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GOLD MINING AND MILLING IN THE BLACK MOUNTAINS, WESTERN MOHAVE COUNTY, ARIZ.

BY

E. D. GARDNER

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GOLD MINING AND MILLING IN THE BLACK MOUNTAINS, WESTERN MOHAVE COUNTY, ARIZ.[1]

By E. D. Gardner[2]

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INTRODUCTION

This is one of a series of papers describing mining and related subjects affecting mining in western mining districts and mineralized areas. The parts of this paper pertaining to current production, mining and milling methods and practices, and general conditions affecting mining were collected principally during a field survey made in May 1935. Some original data obtained on previous visits to the area are also included. The history, geological background, and past production of the mines and district are largely abstracted from previous publications, for which due credit is given later in the text.

The principal districts in the Black Mountains are the Oatman or San Francisco and the Union Pass or Katherine. This range contains the principal producing mines of the State, in which gold is the only important metal. Although the total production of gold is relatively small as compared to other districts where the precious metals are obtained as a by-product in copper mining, the area is one of considerable economic importance to the State.

ACKNOWLEDGMENTS

The operators in the region freely supplied all requested information that was available.

Bemis Phelps, secretary of the Tom Reed Gold Mining Co. furnished considerable data concerning the mines in the Oatman district.

L. V. Root of Kingman accompanied the writer on his visit to the properties on the north end of the range and in addition gave considerable general information regarding the area.

The area was described by Schrader in 1909[3] and again by Wilson in 1934.[4] The Oatman and Katherine districts were described by Ransome[5] in 1923, and by Lausen in 1931.[6] Elsing and Heineman listed the production of the individual mines and the districts in 1936.[7]

3/ Schrader, F. C., Mineral Deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Ariz.: U. S. Geol. Survey Bull. 397, 1909, pp. 151-218.

4/ Wilson, Eldred D., Cunningham, J. B., and Butler, G. M., Arizona Lode Gold Mines and Gold Mining: Arizona Bureau of Mines Bull. 137, 1934, pp. 80-108.

5/ Ransome, F. L., Geology of Oatman Gold District, Arizona: U. S. Geol. Survey Bull. 743, 1923, 58 pp.

6/ Lausen, Carl, Geology of the Oatman and Katherine Districts, Arizona: Arizona Bureau of Mines Bull. 131, 1931.

7/ Elsing, Morris J., and Heineman, Robert E. S., Arizona Metal Production: Arizona Bureau of Mines Bull. 140, p. 96.

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LOCATION

The Black Mountains extend north and south parallel to the Colorado River and from north of Boulder Dam to Toprock (see fig. 1). The range is 100 miles long and 20 miles wide, and its highest peaks attain an altitude of 5,000 feet. The altitude at the Colorado River at the foot of the range below Boulder Dam is between 600 and 700 feet. The eastern side of the mountains is drained through valleys lying at about 3,300 feet and running north and south into the river. Locally the northern section of the Black Mountains is called the River Range.

The town of Oatman, with a population of 647 (1930), is the principal settlement in the area. Another settlement, with a school, (1935) is situated at the Katherine mill. Camps are maintained at a number of other mines. The population of Oatman and the different camps varies with the fortunes of mining in the region. Until the price of gold increased in 1933, the whole range, with the exception of Oatman, was virtually deserted.

The Atchison, Topeka, and Santa Fe Railroad skirts the southern end of the range. Kingman, the county seat of Mohave County, is the main source of supplies. Highway 66, which is paved from Kingman to the coast, passes through Oatman (fig. 1). Timber and other supplies are trucked from Los Angeles to Oatman. Highway 69, from Kingman to Boulder, which serves most of the area was realined recently and graded. It is an excellent dirt road and probably will be oiled soon. A good dirt road extends to the Katherine from Kingman. Mines off the main highway can be reached by desert roads, usually in poor condition but passable for trucks and automobiles.

TOPOGRAPHY

The range is very rugged and deeply dissected by gulches and canyons. The rocks of the central mountains of the range are largely bare. The Oatman district is in a belt of rugged foothills, which flatten out toward the Colorado River to the west.

The Katherine mine is on fairly level ground. The principal producing mines in the region are in the foothills, as shown by the contours on figure 1.

CLIMATE

The region has an arid climate, high temperatures prevailing during the summer. The extreme range of temperature recorded at Fort Mohave[8/] (altitude, 604 feet) is from 3° to 127°. The range at Kingman (altitude 3,326 feet) is 8° to 117°. The temperature at Oatman (altitude 2,700 feet) usually is between those at Kingman and Fort Mohave.

Rainfall, as temperature, depends to some degree upon altitude. The average annual rainfall at Fort Mohave is 5.21 inches and at Kingman 11.50 inches. As elsewhere in Arizona, the rainfall is seasonal; the heaviest rainfall, usually accompanied by electric storms, occurs in July and August. Another rainy season

8/ Smith, H. V., The Climate of Arizona: Univ. of Arizona Agricultural Exp. Sta. Bull. 130, 1930, p. 350.

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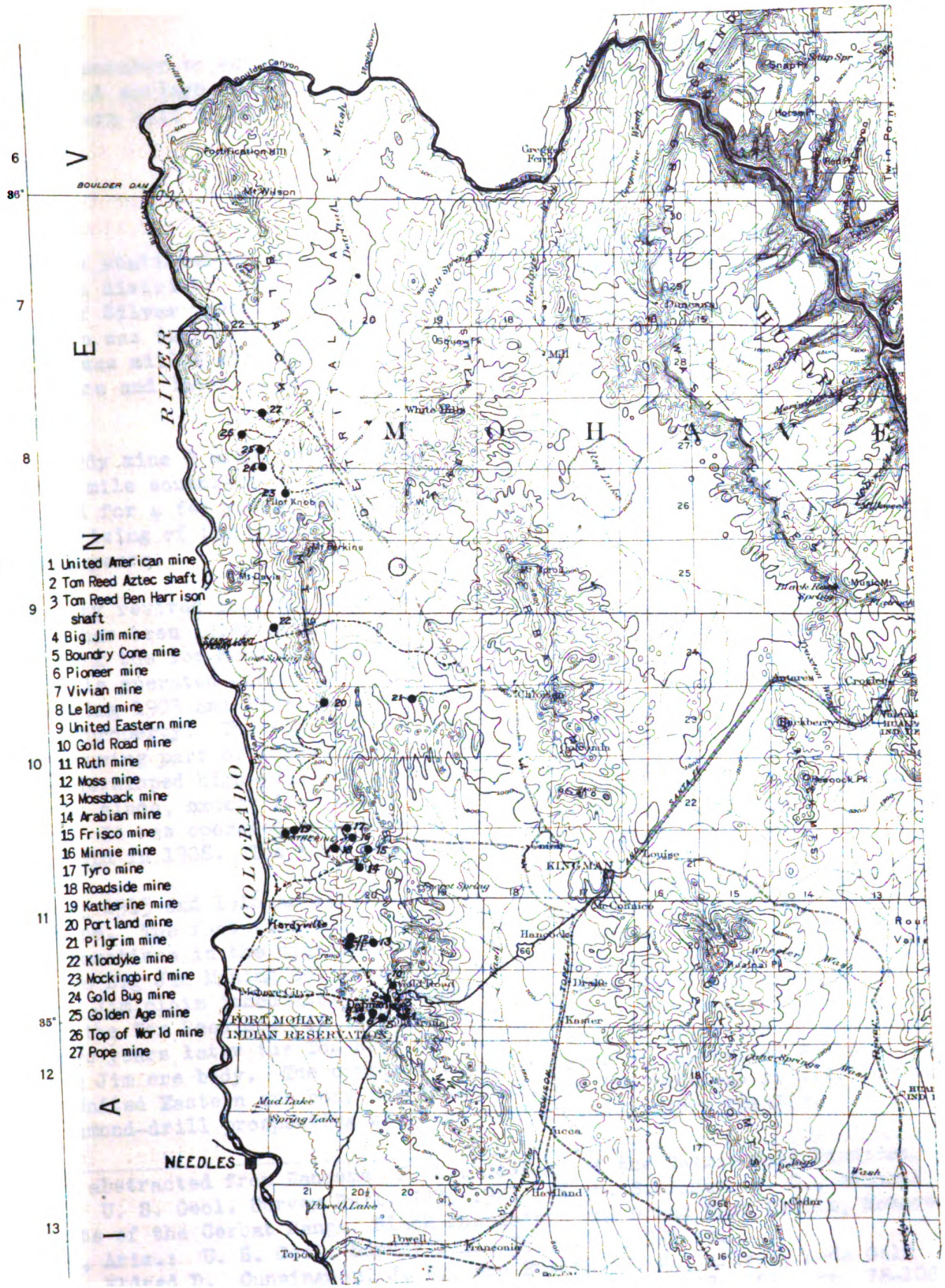

Figure 1.- Map from State contour, western Mohave County, Ariz.

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occurs from December to March. Gulches are dry except after rainstorms. A few small perennial springs, the largest of which are in Silver Creek, occur throughout the southern half of the range.

HISTORY[9/]

Oatman District

Soldiers stationed at Camp Mojave during the early sixties prospected part of the Oatman district. John Moss and party discovered the Moss mine about 1 mile north of Silver Creek in 1863 or 1864; it is reported that $240,000 worth of rich gold ore was taken from a pocket close to the surface during the next few years. Ore was milled first at the settlement on Silver Creek where water came to the surface and later at Hardyville on the Colorado River about 7 miles west of the mine.

The Hardy mine 2 miles west of Goldroad, the Leland on Leland Hill, and the Gold Dust 1 mile southwest of Oatman were discovered soon after. The Hardy mine was operated for a few years, the ore being treated in the Hardyville mill. After an uprising of the Hualpai Indians in 1866, the district was nearly abandoned for several years.

Activity revived in 1900, when rich ore was found in the Gold Road vein. Production has been intermittent since the mine was discovered. In 1901 the Gold Road Co. sank the Tom Reed and Ben Harrison shafts to 100 feet. The Leonora mill at Hardyville operated during part of 1901 and 1902 on ore from the Moss and Hardy veins. During 1903 and 1904 the Mohave Gold Mining Co. did considerable work on the Leland property. The Blue Ridge Gold Mines Co. produced ore from the Tom Reed vein during part of 1904-1905. In 1906 the Tom Reed Gold Mines Co. purchased the mine, developed high-grade ore, and in 1908 started production that has continued ever since, except from March 1932 to early 1934, when the property was shut down. It was operated by lessees from 1923 to 1927. The present cyanide mill was built in 1908. The town of Oatman was established about 1912.

During 1915 and 1916 an $11,000,000 ore body was developed in the United Eastern mine. The fact that this ore shoot did not outcrop encouraged scores of wildcat promotions in the district most of which, however, proved to be futile. In 1916 the Big Jim Mining Co. found an important ore body in the Tom Reed vein on the Big Jim claim immediately northeast of the Grey Eagle and Black Eagle claims of the Tom Reed Co. In 1917 the United Eastern Co. purchased the Big Jim ground; two years later the Tom Reed Co. brought suit to establish an apex claim to the Big Jim ore body. The courts decided in favor of the United Eastern. In 1924 the United Eastern ore body was exhausted, and the mine was closed. Considerable diamond-drill prospecting was done with unsatisfactory results.

9/ Mainly abstracted from Ransome, F. L., Geology of the Oatman Gold District, Ariz.: U. S. Geol. Survey Bull. 743, 1923, 58 pp. Schrader, F. C., Mineral Deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Ariz.: U. S. Geol. Survey Bull. 397, 1909, 226 pp. Wilson, Eldred D., Cunningham, J. B., and Butler, G. M., Arizona Lode Gold Mines and Gold Mining: Arizona Bureau of Mines Bull. 137, 1934, pp. 78-108.

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During 1933 and early 1934 virtually the only work done in the district was carried on by Johnson and Witcher, lessees on the Big Jim; the ore was treated in the 45-ton-per-day Telluride cyanide mill.

With a higher price for gold in 1934 the Tom Reed started its mill and reopened the mine. The company announced a new low rate for custom ore and almost immediately the mill began to run at capacity. In the spring of 1935 it could not take all of the ore offered it. Capacity was increased early in 1936 by adding a new ball mill.

Katherine District

The Sheep Trails mine in the Katherine district about 7 miles east of the river was discovered in 1865 by Jack Mellen, captain of a steamboat running on the Colorado River. A 20-ton stamp mill for treating the ore was built at Pyramid.

The Katherine was discovered in 1900 and other mines in the district soon after. A 150-ton cyanide mill, later increased to 260 tons, was built in 1925 and operated on ores from the Katherine until 1929, when it was closed.

The mill was acquired by the Gold Standards Mines Corporation in 1933. It was running to capacity in the spring of 1935, treating both company and custom ore. The Tyro was the principal shipper of custom ore.

Other Districts

The Pilgrim (now Pioneer) was discovered in 1904, but production was insignificant until the mill was built in 1934.

The Gold Bug mine in the Gold Bug district was discovered in 1892. During 1893 and 1894, 50 tons of selected ore was shipped that netted $43,000, or about $860 per ton. Later a 24-ton amalgamation mill was built at the Colorado River. After a period of idleness the mine was being worked in 1907.

The Mocking Bird and Hall mines in the Mocking Bird district produced from 1900 to 1906 and the Burrows in the Eldorado Pass district from 1892 to 1906. Development work was being done at other properties in 1907. Intermittent small-scale work has been carried on in the district up to the present (1936).

PRODUCTION

Table 1[10/] shows the production of gold and silver of the principal mines in the River Range up to the end of 1933.

10/ Elsing, Morris J., and Heineman, Robt. E. S., Arizona Metals Production: Arizona Bureau of Mines Bull. 140, 1936, p. 96.

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TABLE 1. - Approximate production of gold and silver of the principal mines in the Black Mountains

	Gold value	Silver value	Total value
San Francisco district:			
United Eastern, 1917-1924	$ 13,665,000	$ 400,000	$14,065,000
Tom Reed, 1907-1933	13,100,000	100,000	13,200,000
Gold Road, 1903-1931	7,250,000	50,000	7,300,000
Moss, prior 1900	250,000	.....	250,000
Telluride, 1922-1933	200,000	.....	200,000
Pioneer or German-American, 1896-1906	40,000	.....	40,000
Miller (Hardy), 1870-1906	100,000	.....	100,000
Gold Ore	35,000	.....	35,000
Homestake-Jack Pot	35,000	.....	35,000
Total	$ 34,675,000	$ 550,000	$35,225,000
Katherine district:			
Katherine, 1900-1933	1,700,000	100,000	1,800,000
Frisco, 1893-1933	400,000	.....	400,000
Sheep Trail-Boulevard, 1868-1906	50,000	.....	50,000
Roadside, 1915-1933	20,000	.....	20,000
Arabian, 1917-1933	20,000	.....	20,000
Total	2,190,000	100,000	2,290,000
Mocking Bird district:			
Mocking Bird, 1900-1906	20,000	.....	20,000
Gold Bug district:			
Gold Bug, 1892-1908	60,000	.....	60,000
El Dorado Pass district:			
Burrows, 1892-1906	10,000	.....	10,000
Grand total	36,955,000	650,000	37,605,000

GEOLOGICAL BACKGROUND

The general geology of the range has been described by Schrader.[11/] Ransome[12/] and Lausen[13/] have studied and mapped the geology of the Oatman and Katherine districts in detail. The northern deposits have received comparatively little geologic study.

The southern Black Mountains comprise an eastward dipping block of Tertiary volcanic rocks that rest upon a basement of pre-Cambrian gneiss and granite. The Tertiary formations are cut by numerous northwestward-striking faults. The rock

11/ Work cited (see footnote 3).
12/ Work cited (see footnote 5).
13/ Work cited (see footnote 6).

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common to the western part of the Katherine district is a coarse-grained granite; the mountains to the east comprise the Oatman type of Tertiary volcanic rocks. Farther north, granite, schist, and gneiss predominate. The most important ore-bearing formation is the Oatman andesite termed by Schrader the "green chloritic andesite."

The veins of the Oatman district occur within fissures along which faulting has occurred. These veins are distributed widely, but the most productive are in the northeastern half of the district. The larger veins are essentially stringer lodes of complex structure. Many of the veins are lenticular. A strong vein may pinch down to nothing, or a stringer may thicken to a considerable width in a short distance. Some of the veins attain a maximum width of 90 feet; ore shoots up to 50 feet wide have been mined. Some of the outcrops, as that of the Gold Road vein, are prominent, but others, as the United Eastern, are inconspicuous. The vein system in the Oatman district is shown in figure 2 from Lausen.[14/]

The mineralization has not been shown to extend into the granite or gneiss in the Oatman district; most of the mines in the Katherine district are in granite and a few small mines have been worked in the granite and schist in the Mockingbird, Eldorado Pass, and Gold Bug districts to the north.

The gangue of the veins of the Oatman and Katherine districts consists mainly of quartz and calcite, either of which may predominate. According to Ransome,[15/] vein material that consists entirely of quartz and calcite generally is very low grade or barren. Microscopic adularia is a common constituent of the gold-bearing quartz. Fluorite occurs in some veins but is rare in large ore bodies.

The only valuable minerals found in the area are free gold and a minor amount of silver. The gold is characteristically fine-grained and can be seen only in the rich ore. Pyrite and chalcopyrite are found only rarely in the Oatman and Kingman districts. In the northern districts the gold may be associated with pyrite and galena. Lead vanadinite has been reported at one mine, the Pope. Copper minerals were associated with the gold at the Mockingbird mine.

The Pilgrim mine is in a spur of the range that heads toward Chloride. The gold occurs free, as elsewhere in the range; but the vein, which is in a highly fractured zone, differs from those found elsewhere in the range.

Taking the range as a whole, there is a remarkable similarity in the occurrence of the gold in the veins that are being worked. The ore bodies are usually steeply dipping; most of them are tabular in form and from 3 to 7 feet thick. Although most of the ore shoots are not extensive either on the strike or dip, a few, such as the Gold Road, have been worked for relatively long distances. One ore shoot in the Tom Reed has been worked to a depth of 1,400 feet. The United Eastern ore body, which occurred between the 300- and 850-foot levels, was unusual both in size and richness. Elsewhere in the range no production has come from below 700-feet from the surface.

14/ Work cited (see footnote 6).

15/ Work cited (see footnote 5).

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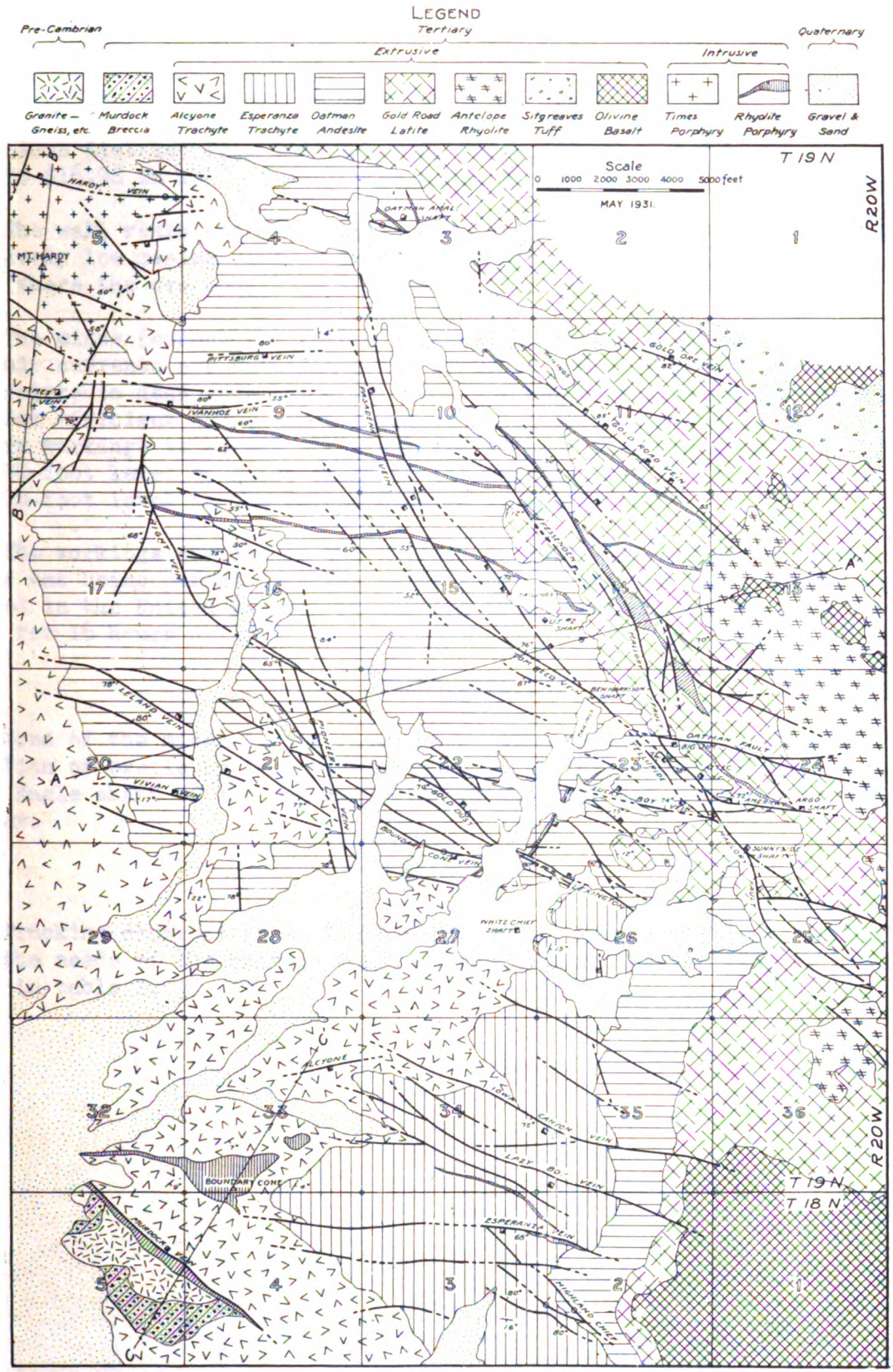

Figure 2.- Geologic map of the Oatman district, Mohave County, Ariz. (after Lausen).

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On the whole, the ore in the area is not high-grade. Careful mining usually is necessary to maintain a milling grade. The average yearly grade of ore from the Oatman district from 1908 to 1928, inclusive, ranged from $3.71 per ton in 1908 to $16.98 in 1924; the average grade for the whole period was $12.37 per ton.

The wall rocks and vein material on the whole stand well, which permits relatively low mining costs. The only important exception is at the Pilgrim mine, where the ore occurs in a fracture zone and under gouge seams.

The mines (except the United Eastern) are ventilated naturally and where good air currents are maintained the workings are fairly comfortable. The temperature in dead ends below the 600-foot level of most of the mines is too high for efficient work. Mechanical ventilation was needed in all of the United Eastern workings to permit efficient operation. Rock temperature in 1920 on the 600-foot level of Aztec shaft of the Tom Reed was 86° F., and in a raise on the 300-foot level in the United Eastern it was 93° F.

The workings are dry on the whole. In 1920, 350 gallons of water per minute was being pumped from the Aztec shaft of the Tom Reed. Water was controlled in the United Eastern by pumping 32 gallons per minute from the tenth level for 16 hours daily.

TRANSPORTATION

None of the mines in the range have rail connections. All surface transportation of ore is by truck except that an aerial tramway is used from the Black Eagle shaft of the Tom Reed mine to the mill belonging to the same company.

Trucking

Trucking contractors at Kingman and Oatman have sufficient facilities to meet the needs of the range. Contract trucking prices for 1933 to 1935 are shown in table 2.

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TABLE 2. - Trucking costs in Arizona

From -	To -	Distance, miles	Tons, daily	Year	Condition of road	Shoveling	Size loads, tons	Price per ton 1/	Cost per ton mile
Oatman district:									
Big Jim mine	Telluride mill	1	45	1933	Good	None	7	$ 0.30	$ 0.30
Ruth-Rattan mine	Tom Reed mill.	9	40	1935	Fair	do.	7	1.25	.14
Mossback mine	do.	9	.....	1934	do.	do.	7	1.25	.14
German- American mine	do.	4-5	15	1935	do.	do.	7	.50	.10
Do	do.	4-5	15	do.	do.	In..	7	.75	.15
Midnight mine	do.	7	2	do.	Good	do.	7	1.25	.18
United Western mine.	do.	2	20	do.	Excellent	None	7	.35	.18
Katherine district:									
Tyro mine	Katherine mill	6	60	do.	Fair	do.	2/ 7	.50	.08
Roadside mine	do.	4	(3/)	do.	Good	do.	7	.30	.08
Arabian mine	do.	8	(3/)	do.	do.	do.	7	.40	.05
Portland mine	do.	15	(3/)	do.	Fair	do.	7	1.12	.07
Frisco mine	do.	10	(3/)	do.	Good	do.	7	.60	.06
River Range:									
Klondyke mine	Tom Reed mill.	82	15	do.	Fair	In..	7	5.00	.06
Eldorado mine	do.	75	(4/)	do.	Good	do.	7	6.00	.08
Pope mine	Kingman R.R. station	53	(5/)	do.	do.	do.	7	3.50	.07
Pilgrim mine	Midvale, Utah.	515	(6/)	do.	Excellent	(7/)	.....	8/ 15.00	.03

1/ All hauling done by contract.
2/ 3½ ton trucks loaded to 7 tons.
3/ Same contractor did all hauling to Katherine mill - total 250 tons daily.
4/ Odd lots.
5/ 50-ton lots.
6/ Odd lots, concentrate.
7/ Sacks.
8/ This includes $2 per ton highway tax in Utah. New rate, after new road built across dam which eliminates curves and hills, $11 exclusive road tax.

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In May 1935 a single contractor hauled virtually all the ore (230 to 250 tons daily) to the Katherine mill with four 3-½ ton trucks loaded with 7 tons each and two 1½ ton trucks loaded with between 3 and 4 tons each. The trucks were worked one shift of from 10 to 14 hours daily; occasionally, however, two shifts were required for a part of the fleet. One driver and one mechanic were employed for each truck.

Freight Rates

Most of the smelting ore in the range is shipped to smelters in the Salt Lake Valley of Utah. The freight tariff on gold ore from Kingman to Midvale, Utah (March 1936), was as follows:

Value of ore	Rate per ton	Value of ore	Rate per ton
$15 to $20.....	$ 5.25	$70 to $80.....	$10.45
20 to 30.....	5.75	80 to 90.....	11.40
30 to 40.....	6.25	90 to 100.....	12.20
40 to 60.....	6.75	over 100.....	13.00

An added charge of 40 cents per ton, called an emergency charge, is assessed against all shipments.

Ore from the Pope mine (fig. 1) in the northern portion of the range was being shipped to the Midvale (Utah) smelter in May 1935. It was hauled 52 miles to Kingman by truck and then 855 miles by rail to Midvale. In January 1936, when the road over the Boulder Dam had been completed, it was trucked 34 miles to Boulder and thence by rail to Midvale a distance of 482 miles.

CUSTOM MILLS

The Oatman district is served by the Tom Reed and Telluride mills, both of which take custom ores. The Katherine mill in the Katherine district treats both company and custom ore. The Pioneer Gold Mining Co. has its own mill at the Pilgrim mine.

Custom rates

The custom rates at the Tom Reed mill in May 1935 were:

	Per ton
35-ton daily lots, or over (on at least 3 consecutive days, or 105 tons).....	$3.60
From 25- to 35-ton daily lots (on at least 3 consecutive days, or 75 tons).....	3.80
25-ton lots or more as individual or irregular shipments....	4.00
Less than 25-ton lots.....	4.50

The Tom Reed Co. paid for 95 percent of the gold in the ore received under the first three schedules. Ninety-two percent of the gold was paid for in ore shipments of less than 25 tons. No payments were made for silver as most of the ore in the district did not contain enough of this metal to justify the expense of assaying. In dry weather a flat deduction of 1 percent of the weight is made for moisture in ores from near the surface. Payment was made to shippers in May

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1935, when the report was received from the Mint on the gold bar from any particular lot.

The Tom Reed also helps finance small operators who have ore in sight. A first lien is taken on the bullion. Repayment is made in installments and, however, is not all held out of the first shipments. The mill is equipped with a complete mechanical sampling plant.

The custom rate at the Telluride mill (May 1935) was $4 per ton; 95 percent of the gold was paid for. The milling rate at the Katherine in May 1935 for Tyro ore (60 tons daily) was $3.50 per ton. Ninety-two percent of the gold was paid for in shipments that assayed 0.15 ounces of gold to the ton; for each 0.01 ounce increment in the value of the ore the rate of payment was increased 0.1 percent, up to a maximum of 95 percent. For an ore containing 0.42 ounce per ton, 94.7 percent of the assay value would be paid. The shipper received payment for 30 percent of the silver in the ore.

SMELTER RATES

The following are two representative open-smelter schedules at a plant that receives ore from the northern districts in the area.

Lead schedule

Sampling is done free of charge by the smelting company or at the shipper's expense at a custom sampler. Payments are as follows:

Gold:

If from 0.02 ounce to 5 ounces per ton, at 92 percent Mint price.
If over 5 ounces and up to 10 ounces per ton, at 94 percent Mint price.
If over 10 ounces per ton, 96 percent Mint price.

Silver:

95 percent Mint price. No payment for less than 1 ounce.

Lead:

90 percent of dry assay (wet assay less 1-½ units) on Engineering and Mining Journal quotation for week preceding delivery less 1-½ cents per pound. No payments are made for less than 3 percent.

Copper:

90 percent of wet assay at Engineering and Mining Journal quotation week preceding delivery, less 5-½ cents per pound; minimum deduction 15 pounds.

Iron:

Paid for at 6 cents per unit (20 pounds).

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Charges

Insoluble: Charged for at 10 cents per unit.
Zinc: 6 percent free; excess charged for at 30 cents per unit.
Sulphur: 2 percent free; excess charged for at 25 cents per unit; maximum charge $2.50.
Treatment: $2.50 per ton on the basis of 30 percent lead. Debit 10 cents for each unit under 30 percent and credit 10 cents for each unit above 30 percent.

Copper Schedule

Payments:

Gold and silver: - The same as for ore shipped under the lead schedule.
Copper. - 90 percent of wet assay at Engineering and Mining Journal quotation for week preceding delivery, less 3 cents per pound; minimum deduction 15 pounds.

Charges:

Treatment. - $3.70 per ton based on gross value of gold, silver, and copper of $20 per ton, with 10 percent of the excess gross value over $20 per ton added to the treatment charge, up to a maximum treatment charge of $7.70 per ton.

Zinc. - 6 percent free; excess charged for at 30 cents per unit.

On lots of less than 10 tons a sampling and assaying charge of $10 for the lot is made under both schedules. Concessions are made sometimes to a shipper who can supply a steady tonnage and for ores that have special fluxing qualities.

WATER SUPPLY

Water for mining and milling at Oatman is obtained mostly from mine shafts. Domestic water comes through a 6-inch pipeline from wells in Cottonwood Creek about 3 miles distant.

The water table in the Katherine shaft is 100 feet above the elevation of the Colorado River. In May 1935 water for milling was pumped from the river. Water is scarce in the northern part of the range; so far the only demonstrated supply is the Colorado River. Enough for camp use has been found in wells in a few localities. Two small mills were being operated with water pumped from mines in 1907.

POWER

The Oatman and Katherine districts are served with power by the Citizen's Utility Co. of Kingman, Ariz. A modern Diesel plant was erected in 1936 by the Pioneer Gold Mining Co. and a few smaller properties use semi-Diesel or gasoline engines. The following schedule was furnished by the utility company (March 1936):

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Combined milling and mining power service

Applicable to mine power installations, 50 percent of the connected loads of which are used for milling purposes and which milling load exceeds 75 horsepower of demand (nameplate equipment rating) and where the customer owns and maintains the transformer substation.

Territory. - All territory served by the company in Mohave County.

Rate. - For consumption of stated quantities within a period of one calendar month or any part thereof;

From	1	to	20,000	kw.-hrs.	per	month	at	$0.0265	per	kw.-hr.
	20,001	to	100,000	"	"	"	"	.0225	"	"
	100,001	to	200,000	"	"	"	"	.02	"	"
In excess	of 200,000			"	"	"	"	.0175	"	"

Subject to a fuel oil differential, increased cost of $0.00025 per kw. hr. for each 5 cent variation above a base fuel oil cost of $1.50 per barrel, and a decreased cost of $0.00025 per kw.-hr. for each 5 cent variation below a base fuel oil cost of $1.25 per barrel, f.c.b. Kingman, Ariz.

The minimum monthly charge for service under this schedule shall be $1 per kv-a of transformer capacity for the first 100 kv-a, plus $0.50 per kv-a for each kv-a of transformer capacity in excess of 100 kv-a.

Less the applicable proportionate part of any decrease or plus the applicable proportionate part of any increase in taxes or governmental impositions which are assessed on the basis of gross revenue of the company and/or the price or revenue from the electric energy or service sold and/or the volume of energy generated or purchased for sale and/or sold hereunder as may be effective May 15, 1935.

Special conditions

(a) Service under this schedule shall be supplied at 44,000 volt, 3-phase, 60-cycle, alternating current.
(b) Metering shall be on the secondary side of the transformer.
(c) Energy under this schedule is supplied only on written agreement covering line construction, service term, minimum consumption, surety deposit, operating use of energy, etc.

Mine and industrial power service

Applicable to mine and industrial power where the customer owns and maintains the transformer substation.

Territory. - All territory served by the company in Mohave County.

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Rate

Base rate - $0.03551425 kw.-hr.

Subject to a fuel oil differential of $0.000284 per kw.-hr. for each 5 cent variation in the cost of fuel oil above or below a base cost of $2.972 per barrel, the net being reduced to four decimal places.

Quantity discounts

Quantity discounts are allowed on bills paid on or before the tenth day of the month succeeding that in which service was rendered:

Kw.-hr. per month	Percent
From 1 to 20,000	net
20,001 to 100,000	7.5
100,001 to 150,000	10.0
150,001 to 200,000	12.5
200,001 to 250,000	15.0
250,001 to 300,000	17.5
300,001 to 350,000	20.0
350,001 to 400,000	22.5
400,001 and upwards	25.0

The minimum monthly charge for service under this schedule shall be $1 per kv-a of transformer capacity for the first 100 kv-a, plus $0.50 per kv-a for each kv-a of transformer capacity in excess of 100 kv-a

Rate calculation

Base rate - - - - - - - - - - - - - - - - - -	-$0.03551425
Fuel oil differential (-30 x $.000284) - -	.008520
Difference - - - - - - - -	-$ .026999425
Effective net rate - - - - - - - - - - -	$.027

Less the applicable proportionate part of any decrease or plus the applicable proportionate part of any increase in taxes or governmental impositions which are assessed on the basis of gross revenue of the company and/or the price or revenue from the electric energy or service sold and/or the volume of energy generated or purchased for sale and/or sold hereunder as may be effective May 15, 1935.

Special conditions

(a) Energy under this schedule is supplied at 44,000-volt, 3-phase, 60-cycle, alternating current.
(b) Service will be metered on the secondary side of the transformers.
(c) Energy under the schedule is supplied on written agreement covering line construction, service term, minimum consumption, etc. Estimates and details on request.

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The following notations regarding their application may be of interest:

1. On related mining operations under one ownership in the same district we combine meter readings from two or more banks of transformers or substations in computing the monthly charge.

2. There are no demand charges of any nature in either rate.

3. No load factor or power factor requirements are made.

4. There have been no taxes imposed since the effective date of these schedules affecting the rate by reason of the tax clause.

5. Service in December 1935 was rendered through approximately one hundred miles of transmission system and sixteen substations having a combined capacity of 4,155 kv-a. The average rate realized for that month was $.0192. The maximum in any instance was $.027.

6. Only one mine power customer in the group served in December 1935 was receiving service in November 1932, and the service taken at that time was not used in mining.

LABOR

In 1934 and 1935 skilled labor was plentiful in the Oatman and Katherine districts. All local mine workmen were employed, but many miners had drifted in from the copper camps in Arizona, which were then largely shut down. Eight-hour shifts were worked. The wage scale in the Oatman district was as follows:

	1933-1935		1933-1935
Miners.....	4.50	Hoist engineers.....	5.00
Timbermen.....	4.50	Blacksmiths.....	5.00
Muckers.....	4.00	Cage tenders.....	4.50
Carmen.....	4.00		

LEASING

Considerable leasing is done in the Oatman district. The following tabulation shows the royalties charged by the Tom Reed Gold Mines Co. in March 1934.

Value of ore, per ton	Percentage royalty	Value of ore, per ton	Percentage royalty
Up to $10.....	5	From $30 to $35...	30
From $10 to $12.,,	6	From $35 to $40...	35
From $12 to $15...	9	From $40 to $45...	40
From $15 to $20...	15	From $45 to $50...	45
From $20 to $25...	20	From $50 and over.	50
From $25 to $30...	25		

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The royalty charged by the Pioneer or German-American in May 1935 was as follows:

Value of ore per ton	Percentage royalty	Value of ore per ton	Percentage royalty
Up to $15.....	10	From $60 to $70....	35
From $15 to $25...	15	From $70 to $80....	40
From $25 to $40...	20	From $80 to $90....	45
From $40 to $50...	25	Over $90.....	50
From $50 to $60...	30		

MINING AND MILLING

Shrinkage, cut-and-fill, and open-stope methods are being used in the mines of the range. The gold in the ores is free, finely divided, and dissolves readily in cyanide solutions. The ore, except in rare cases, contains no cyanicides and on the whole is admirably adapted to treatment by the cyanide process.

Flotation is used at one mill (the Pilgrim), although the gold has the same characteristics as elsewhere in the range. The large amount of clay and gouge in the ore presents such a difficult settling problem that cyaniding has not proved economical.

Mining and milling practices, together with costs where available, are given in the descriptions of the individual mines.

The principal mines operating in the district in 1935 together with operating data are shown in table 3.

All of the ore produced in the Oatman district except that from the Mossback is treated in the Tom Reed and Telluride mills; that from the Katherine district goes to the Katherine mill. Odd lots also are received by these mills from elsewhere in the range. As shown by the table, about 600 tons of ore are being milled regularly in the range; occasionally additional shipments are sent to smelters outside the State.

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TABLE 3. - Operating data, principal mines in Black Mountains, 1935.

Mine	Company		Agent in charge	Daily tonnage	Number of men employed		
					Surface	Underground	Total
Oatman district:							
Tom Reed	Tom Reed Gold Mines Co..	Oatman	Jack Zwinge	1/225	45	56	2/100
Big Jim 3/	Big Jim Operating Co....	do.	Rae L. Johnston	45	6	13	2/ 19
Gold Road	United States Smelting & Refining Co.....	do.	L. H. Duriez...	4/ 33	.....	.....	40
Ruth-Rattan	Oatman Eastern Mines Co..	do.	James J. Moss..	4/ 40	6	12	2/ 18
Mossback	Mollin Mining Co.....	do.	Chas. A. Smith.	10	9	6	2/ 15
Pioneer or German-American	Amulet Mines Co.....	do.	Geo. F. Moser..	4/ 15	.....	.....	5/ 23
United Eastern and Telluride	Oatman Associates Mining Co.....	do.	J. L. McIver...	4/ 5	4	10	2/ 14
United Western 6/	Consolidated Gold Mines	do.	T. E. Wood.....	4/ 20	6	10	2/ 16
Lexington	do.....5/....	do.	do.....	n.....	.....	.....	5/ 4
Midnight	Hautier and Waters.....	do.	L. V. Hautier..	4/ 2	.....	.....	5/ 2
Katherine district:							
Roadside, Arabian, Frisco, Portland, Minnie	Gold Standards Mines Corp.	Kingman	Richard De Smet	1/250	28	25	2/ 53
Tyro	White Spar Mining Co....	do.	R. A. Elgin....	7/ 60	4	20	2/ 24
Pilgrim district:							
Pioneer (Pilgrim).	Pioneer Gold Mining Co..	Chloride	E. F. Hastings.	75	.....	.....	73

1/ Mill.
2/ From 24th annual rept. of State mine inspector for year ended Nov. 30, 1935, last inspection.
3/ Closed January 1936.
4/ Included in Tom Reed tonnage.
5/ Lessees, May 1935.
6/ Closed May 1, 1935.
7/ Included in Katherine mill tonnage.

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Oatman district

The location of the mines and geology of the Oatman district are shown in figure 2 from Lausen.16/

Tom Reed

The Tom Reed has been the most consistent producer in the range and, next to the United Eastern, has had the largest production. The daily capacity has been from 20 tons in 1904 to 220 in 1931. With the fineness of grinding used in 1935, the mill had a capacity of 200 tons daily.

In May 1935, of the 200 tons being milled daily, 75 tons came from the Aztec and Black Eagle and 25 tons from the Ben Harrison. This ore was produced on company acccunt. An additional 50 tons daily was being mined from Tom Reed ground by 20 sets of lessees (56 to 60 men) and about 50 tons of outside custom ore was being received.

In the year April 1, 1934, to March 31, 1935, 58,834 tons of ore was received and 58,791 tons milled. The value of the bullion shipped was $117,368. The mill heads contained an average of $11.41 in gold.

The company had a lease on the Argo, which adjoins the Tom Reed on the west, and was drifting on the Tom Reed vein in this ground.

Water for milling is obtained from the mine.

Mining. - The Tom Reed vein is continuous for about 1-½ miles on the strike (fig. 2). The three most important ore shoots are localized within 2,000 feet along the fracture. The fracture is barren for another 2,000 feet to the important Big Jim-Aztec ore shoot, which has a length of over 1,500 feet. The average width of all shoots is probably about 6 feet.

The property has a complete mine plant. The principal items of mine equipment are a 150 horsepower hoist, three compressors with a combined capacity of 4,000 cubic feet of air per minute, and an aerial tramway about 1 mile long.

The mine is developed by four main shafts - the Ben Harrison, 900 feet deep; Aztec, 700 feet deep; Grey Eagle, 425 feet deep; and Black Eagle, 1,100 feet deep. A winze from the 700-foot level of the Ben Harrison reaches the 1,400-foot level. The total underground workings amount to about 15 miles. Levels are 100 feet apart.

Stoping. - Shrinkage and horizontal cut-and-fill stoping have been the principal methods used in the Tom Reed mine. Chutes (raises in cut-and-fill stopes) are carried up 20 feet apart; manways are 125 feet apart.

Since reopening in 1934, much of the mining has been done in narrow parts of the vein between worked-out shoots and around old stopes; more timbering than formerly has been necessary. Open stoping with stulls is used in the narrow parts of the vein together with a little shrinkage. The open stopes and emptied shrinkage stopes are filled when development rock or sorted waste is available.

16/ Work cited (see footnote 6).

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Mining cost. - The mining cost for the 1934 fiscal year was $1.73 per ton. The cost of transportation on the tramway was $0.20 per ton.

Milling. - Standard countercurrent cyanidation is used in the Tom Reed mill. Flow sheets similar to those employed in the United Eastern plant are used in the Katherine and Telluride mills.

The flow sheet of the mill (1936) is shown in figures 3, 4, and 5. These figures were supplied by P. U. Brough, mill superintendent. In May 1936 a new 40-by 12-foot thickener was being installed at a higher elevation. This will be the future tailing thickener. The present tailing thickener will be converted into an agitator as longer contact is needed at the present tonnage rate.

The run-of-mine ore was crushed in the Traylor crusher to minus 2 inches. Grinding was done in solution in a (primary) 6- by 5-foot ball mill and two (secondary) 5- by 6-foot ball mills. The first mill was in a closed circuit with a Model C Duplex Dorr classifier 4 feet 6 inches by 14 feet 6 inches that made 26 strokes per minute. The overflow, which was minus -10 mesh, went to two other classifiers. The drag product went to the two secondary ball mills which, in turn, were in closed circuit with two classifiers. The overflow from these last classifiers was 85 percent through 200 mesh.

The overflow from the two intermediate classifiers and the last two went to a 40 by 12 primary thickener, the rake of which revolved one-sixth revolution per minute. The overflow went to a gold-storage tank. The pulp went through three 30- by 12-foot agitators, the arms of which revolved at 3 r.p.m. Air under a pressure of 20 pounds per square inch was used for agitating. Cyanide was added to the No. 1 agitator to maintain a strength of 2.3 pounds of cyanide per ton of solution. The pulp in the agitator contained 40 percent solids. The solution in the mill circuit contained 1-½ pounds cyanide and 1 pound lime to the ton of solution.

In 1934, when 122 tons were treated daily, the ore was agitated for 5 days. From the third agitator the pulp was removed by a diaphram pump to the suction of a Wilfley pump which, in turn, delivered it to the head of a series of five thickeners that comprised the countercurrent system of the mill. Wash water, which was also the make-up water of the mill, was added to the no. 5 thickener, and barren solution was added to no. 3. The overflow from no. 1 went to the mill-solution tank. The discharge from no. 5 tank, which was the mill tails, contained 60 percent solids.

The solution in the discharge contained 0.4 pound cyanide, 0.5 pound lime, and 20 cents gold per ton of solution. The gold lost in solution equaled 12 cents per ton of tailings. The total gold in the tailings amounted to 43 cents per ton (March 1934). The over-all mill saving was 95.5 percent. Seventy percent of the gold was dissolved from the ore during grinding.

The solution from the gold-storage tank was divided - part was pumped to the mill-solution tank and part went through a clarifier, thence to two batteries of Merrill filter presses for the removal of gold. Each press contained twenty-six 36-inch triangular leaves. With the exception that the Tom Reed mill has no Crowe vacuum, the gold-precipitation plant is the same as at the United Eastern, described by Bagley on page 436 of volume 119, Engineering and Mining Journal, March 14, 1935.

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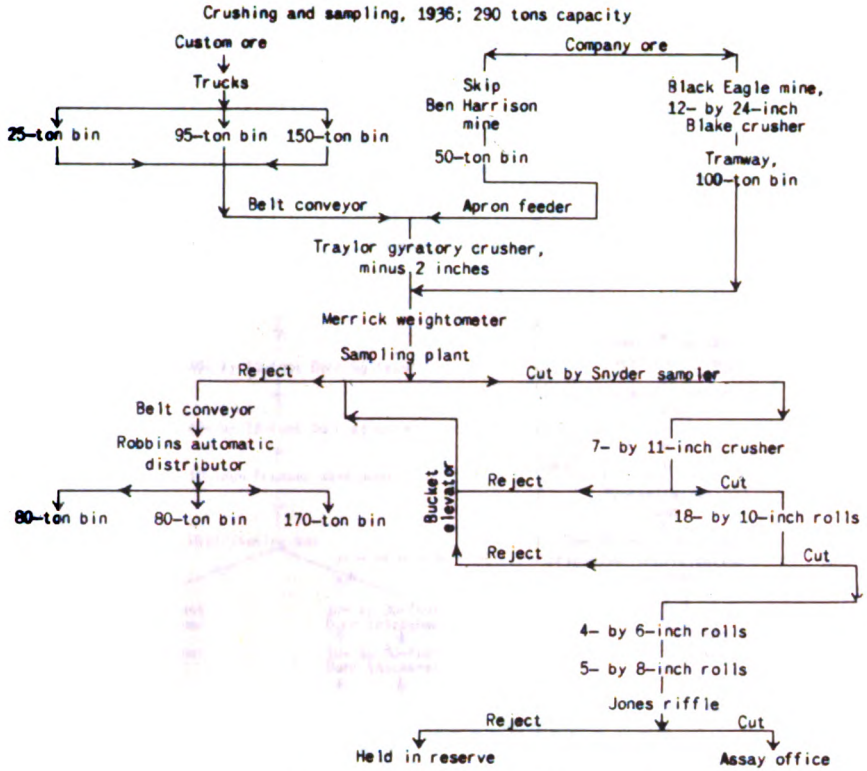

Figure 3.- Tom Reed flow sheet

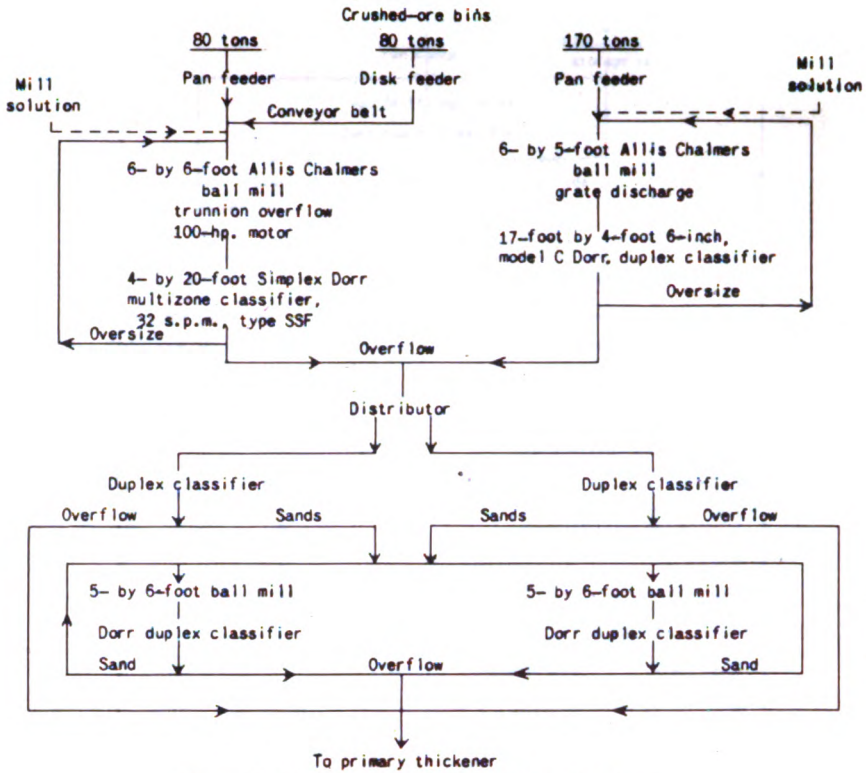

Figure 4.- Flow sheet, Tom Reed grinding circuit.

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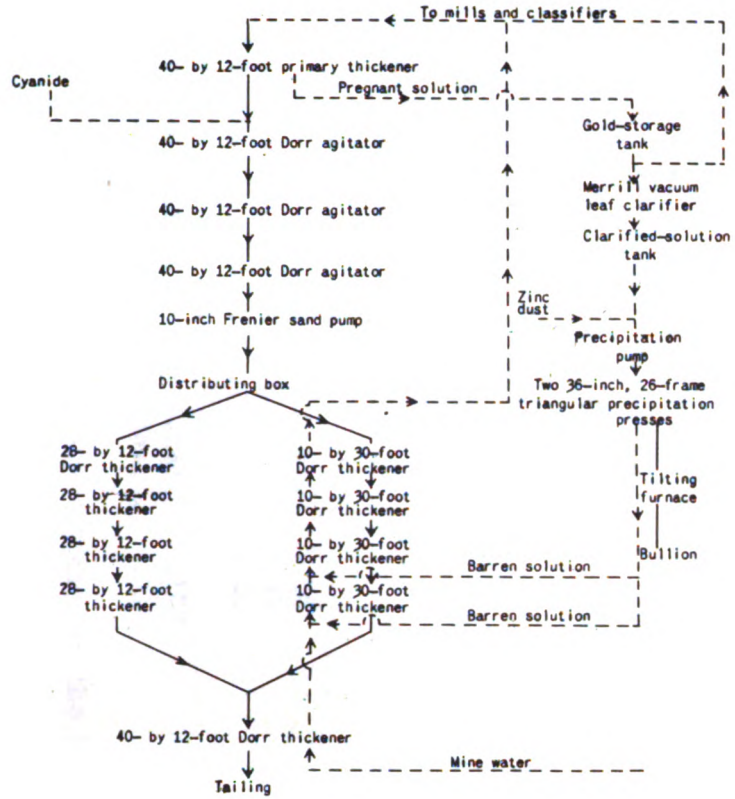

Figure 5.- Flow sheet of Tom Reed treatment plant, 1936.

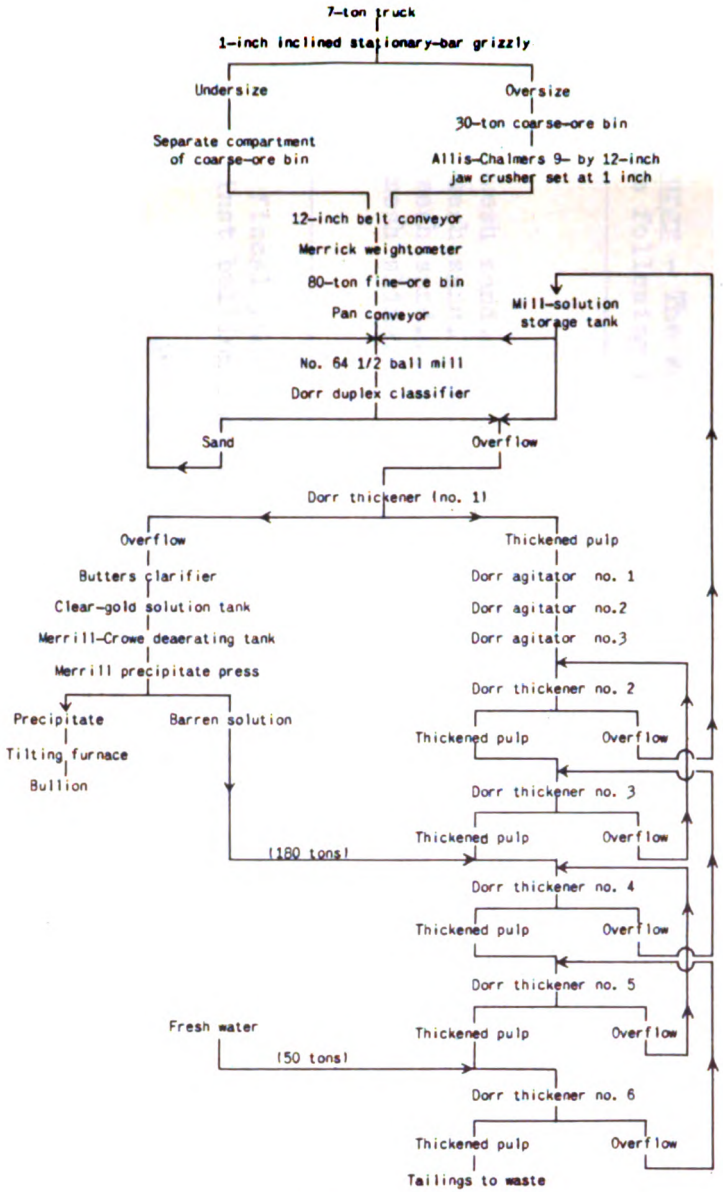

Figure 6.- Flow sheet of Big Jim (telluride) mill.

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The filters were cleaned up twice a month. The method of cleaning followed at the United Eastern was used. The bullion is 880 fine with one melt.

Metallurgy - The screen size and value of the tailings in April 1935 are shown in the following tabulation. The tailing discharge was 53 percent solids.

	Percent of total	Value		
		Ton of sample	Ton of ore	Percent of total
+ 150-mesh sand.....	4.6	$ 1.75	$0.0805	15.8
+ 200-mesh sand.....	12.2	1.40	.1708	33.5
- 200-mesh sand.....	22.0	.70	.1540	30.3
- 200-mesh slime.....	61.2	.17	.1040	20.4
	100.0		$0.5093	100.0

In the fiscal year April 1, 1934, to March 31, 1935, recovery was as follows, figured against bullion recovery and composite tail sample.

Average daily tonnage.....	$161.00
Average mill heads.....	11.408
Average mill tails.....	.549
Average recovery gold.....	95.19 percent
Average silver recovery.....	60.00

The company does not regularly assay for silver, as it occurs in too small amounts to justify the expense.

In March 1935 the tailing loss was as follows:

	Gold	Silver
Washed tailings.....	$0.49	$0.129
Solution loss.....	.052	.005
Total loss.....	$0.542	$0.134

The indicated recovery was 95.69 percent.

Supplies - The ball and reagent consumption (April 1935) was as follows:

Ball consumption, pounds per ton:

5-inch balls.....	1.93	
2-½-inch balls.....	2.63	4.56
Cyanide (Aerobrand), pounds per ton ore.....		1.41
Lime, pounds per ton ore.....		4.44
Zinc dust, pound per ton ore.....		.47
Zinc dust, pound per ton solvent precipitated...		.145
Zinc dust, pound per ton, fine ounce bullion....		.71

Power. - Power is purchased from the local utility company at the rates previously shown. The consumption of power in May 1935 was 32.8 kwh. per ton ore. The motor set-up in the mill follows.

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Equipment	Horsepower of motor
Traylor gyratory	40
Pan feeder	3
Belt elevator	10
Sampler	25
Belt conveyor	5
Crusher	40
Ball mill (primary)	100
Ball mills (secondary, two 75)	150
Ball-mill feeder and classifier	5
Secondary classifiers	5
Agitators (three 9)	27
Thickeners (six 5)	30
Wilfley pump to thickeners	5
Solution pump (four 3)	12
Mill circulating solution pump	15
Precipitating pump	10
Clarifying pump	10
Air compressor (some air to mine)	60
	552

Labor. - The number of men employed in the mill in March 1934 (122 tons per day) was as follows:

Aerial tramway	3
Crusher and sampler	1
Ball-mill operator (2 shifts)	2
Solution men (3 shifts)	3
Refinery man	1
Tailing man	1
Superintendent	1
Assayer	1
Total	13

One-half the wages of the two upper terminal men and one-half of the salary of the assayer were charged to mining.

Milling costs. - The milling cost in 1934, when 122 tons was treated daily, was $2.60 per ton. Amortization and depreciation for taxation purposes was figured at $0.70 per ton. For the year April 1, 1934, to March 31, 1935, the direct milling cost was $1.73 per ton (161 tons daily). The grinding cost was $0.60 per ton.

Total costs. - The costs per ton in the fiscal year 1934 were:

Mining	$4.34
Aerial tram	.20
Milling	1.73
Other costs	.79
Total	7.06

These do not include depreciation or depletion.

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United Eastern

Production in the United Eastern by the United Eastern Mining Co. was begun in January 1917, and the known ore bodies (United Eastern and Big Jim) were exhausted in May 1925[17] and the mines closed.

The Big Jim part of the property was leased to Johnston and Witcher in 1932; this operation is described in a subsequent section of this paper.

In May 1935 Oatman Associates Mining Co. had a lease on the United Eastern; some selected old tailing and clean-up material from the site of the United Eastern mill had been shipped to the Tom Reed mill. The main shaft of the United Eastern had been retimbered to the 300-foot level and a drift begun around the old filled stopes with the hope that with the higher price of gold it would pay to work the margins.

The mining methods and records of the United Eastern Mining Co. have been recorded by Moore.[18] The mine surface plant, mill construction, and plant operations have been described by Wartenweiler.[19] Mill operations have been described by North[20] and Bagley.[21]

Surface plant. - The equipment at the main hoisting shaft consisted of a double-drum electric hoist direct-connected to a 150 horsepower motor. Ore was hoisted in skips working in balance, each skip being suspended below a cage used to handle men, supplies, and waste. The skip loads averaged 2.2 tons; the maximum hoisting speed was 800 feet per minute. Air was supplied by two belt-driven 19- by 12- by 16-inch compressors; each furnished 888 cubic feet of air at 100 pounds per square inch pressure. Shops and the main surface plant were at the hoisting shaft.

Mining. - The No. 1 shaft was sunk to the sixth level for prospecting and development. Later No. 2, a main working shaft with eight levels, was sunk to a depth of 1,000 feet.

The top of the United Eastern (called Tom Reed Extension by Moore) ore body was on the 300-foot level and the bottom was on the 850-foot level. The maximum dimensions were: 750 feet high, 950 feet long, and 48 feet thick.

The horizontal cut-and-fill method of stoping was used almost exclusively in the United Eastern ore body. In preparing for stoping, the vein was silled out on the drift level and timbered with square-sets. Cribbed manways and chutes were run on 22.5-foot centers where the vein was not over 18 feet wide. Where the vein was wider double rows of manway chutes were constructed with the same longitudinal spacing. Waste for filling was obtained from development and waste raises run into the walls between chutes. Ten-inch grizzlies were used at the shaft pockets.

17/ Moore, Roy W., Mining Methods and Records at the United Eastern Mine: Trans. Am. Inst. Min. and Met. Eng., vol. 76, 1928, p. 71.
18/ Work cited (see footnote 17).
19/ Wartenweiler, Otto, The United Eastern Mining and Milling Plant: Trans. Am. Inst. Min. and Met. Eng., vol. 59, 1918, p. 274.
20/ North, W. O., Mill Operations at the United Eastern During 1917 and 1918: Trans. Am. Inst. Min. and Met. Eng., vol. 63, 1920, p. 548.
21/ Bagley, E. M., Operations at United Eastern Mill: Eng. and Min. Jour., vol. 119, 1925, p. 436.

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Tramway. - Ore from the Big Jim shaft was transported to the United Eastern mill by a Riblet aerial tramway with 35 buckets of 10-cubic-foot capacity; the loads averaged 0.52 ton each. The terminal ore bins were 5,080 feet apart; the buckets discharged at an elevation 8 feet higher than the loading plant. The tramway easily handled 300 tons per 8 hours with two men.

Milling. - The mill capacity was 260 tons daily in 1918 and was gradually increased to 325 tons per day in 1922.

The flow sheet was similar to that used at the Tom Reed. The average recovery was 96.59 percent.

A typical screen analysis as given by Bagley,[22] is shown in table 4.

TABLE 4. - Typical screen analysis

Coarse grinding

Mesh	Marcy discharge	Classifier "drag over"	Classifier overflow
Plus 4.....	1.0	2.5	. . .
Plus 6.....	2.5	9.5	. . .
Plus 8.....	7.5	19.0	. . .
Plus 10.....	16.0	35.0	. . .
Plus 14.....	28.0	54.0	. . .
Plus 20.....	37.0	67.0	4.0
Plus 30.....	54.0	81.0	19.0
Plus 48.....	61.0	85.0	28.0
Plus 65.....	66.0	88.0	37.0
Plus 100.....	70.0	89.5	44.0
Plus 150.....	73.0	91.0	48.0
Plus 200.....	77.0	93.0	66.0
Minus 200.....	23.0	7.0	34.0

Fine grinding

Mesh	Ball-mill discharge	Classifier "drag over"	Classifier overflow	Cone overflow
Plus 48.....	4.07	5.43	. . .	. . .
Plus 65.....	11.12	13.71	. . .	. . .
Plus 100.....	24.18	30.00	. . .	. . .
Plus 150.....	43.75	57.30	5.01	0.12
Plus 200.....	63.75	81.40	23.55	7.08
Minus 200.....	36.25	18.60	76.45	92.92

22/ Work cited (see footnote 21).

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Consumption of supplies was as follows:

	Pounds per ton
Cyanide	0.713
Zinc	1.675
Zinc dust	.368
Lime	4.849
5-inch balls	1.049
2-inch balls	2.013

Power consumption was 23.021 kw.-hr. per ton.

Costs and production data. - Production and cost data at the United Eastern mine are shown in tables 5, 6, 7, 8, 9, and 10, inclusive. The tables include both the United Eastern and Big Jim ore bodies.

TABLE 5. - Production at United Eastern mine, 1917-24

Ore milled, United Eastern, tons	511,976
Value	$10,770,606
Ore milled, Big Jim, tons	220,552
Value	$ 3,804,128
Total, ore milled, tons	732,528
Gross value ore milled	$14,558,210
Value of ore, per ton	$ 19.874
Loss in tailing	$ 495,065
Loss per ton	$ 0.676
Values recovered	$14,063,145
Total costs amount	$ 5,920,211
Total costs per ton	$ 8.082
Income from direct operations	$ 8,142,934
Miscellaneous income	$ 17,941
Administration expense	$ 143,705
Net income from operation	$ 8,017,169

TABLE 6. - Mine operating costs at United Eastern mine, 1917-24

Labor	$ 2.581
Timber	.453
Explosives	.502
Other supplies	.298
Power	.284
Miscellaneous	.214
Total	4.332

TABLE 7. - Milling costs in labor and supplies, United Eastern mill, 1917-24

Labor	$0.507
Supplies	.831
Power	.593
Miscellaneous	.063
Total	1.994

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TABLE 8. - Average milling costs, United Eastern mill, 1917-24

General	$ 0.161
Lighting expense	.005
Water supply	.103
Coarse crushing	.055
Coarse grinding	.356
Fine grinding	.469
Cyaniding	.523
Tailing disposal	.025
Clarification	.033
Precipitation	.095
Refining	.074
Sampling	.003
Assaying	.031
Retreating skimmings	.014
Mill heating	.031
Solution recovery system	.010
Experimental work	.001
Total	1.994

TABLE 9. - Indirect cost at United Eastern, 1917-24

Superintendence	$ 0.121
Office expense	.133
Legal expense	.119
Taxes	.727
Liability expense	.080
Accident expense	.079
Fire insurance	.037
Miscellaneous	.119
Total	1.415

TABLE 10. - Summary of costs at United Eastern, 1917-24

Mining	$ 4.332
Milling	1/ 2.011
Shaft sinking	.140
Indirect	1.415
Tramway and mill addition	.062
Marketing	.122
Total	8.082

These costs are exclusive of depletion, depreciation of plant, prepaid development, federal income taxes, and litigation expenses.

1/ For a slightly longer period than covered in table.

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Big Jim

The Big Jim was acquired by the United Eastern in 1915, and an aerial tramway was erected in 1922 to transport the ore to the United Eastern mill about 5,000 feet distant.[23]

From 1921 to 1924, when the United Eastern ceased operation, 220,000 tons of ore with an average value of about $17.25 per ton was produced from the Big Jim.

The Big Jim was leased in 1932 by Rae L. Johnston and Roy S. Witcher. This was the only operation in the district at the time and until the Tom Reed started up in 1934.

The ore was treated in the Telluride mill, which had an average capacity of about 45 tons daily; the range was from 35 tons in winter to 60 in summer. In April 1933, 50 tons per day was being mined, with 10 men underground and 3 on the surface. In May 1935 the mine had difficulty in keeping the mill operating full time. In early 1936 operations in the Big Jim had become unprofitable and ore was being mined elsewhere for milling.

The Big Jim was described by Moore[24] as a fissure vein in andesite. The ore body was 450 feet high and 850 feet long and had a maximum width of 35 feet. The vein dipped 70°. The Johnston and Witcher operations were confined mainly to stoping at the ends of the old workings and mining parallel fractures.

A three-compartment shaft was sunk on the hanging-wall side of the vein to a depth of 730 feet. The ore body, which did not outcrop, was developed by five levels; the first level was above the ore and the lowest below the bottom of the shoot.

Surface plant. - Two Imperial-type compressors constituted the surface equipment one 19- by 12- by 16-inch and the other 17- by 10- by 14-inch. The capacities were 1,100 and 600 cubic feet of free air per minute, respectively. The smaller compressor, with a 75-horsepower motor, was used by Johnston and Witcher. In place of the large double-drum hoist used in the former operations the lessees installed a single-drum hoist run with a 60-horsepower, distillate-burning engine capable of raising a 1-ton skip on the cage at 250 feet per minute.

Stoping. - The original ore body was mined by the United Eastern by a horizontal cut-and-fill and shrinkage method. The ore mined by Johnston and Witcher was 3-½ to 6 feet wide and between strong walls. A block between the 300- and 600-foot levels was mined by the open-stope method with stulls to hold working platforms. Later an extension of the ore body on the 600-foot level was developed and mined by underhand open stoping. A raise was first put up to the level above, and, as stoping progressed, a second and then a third raise was started at intervals of 50 feet.

A series of benches was carried downward by drilling down-holes with jackhammers; the rill was maintained steep enough that the ore would run by gravity into the chutes. One miner would drill 15 to 20 holes and break 20 to 25 tons of ore per shift.

23/ Johnson, C. H., Mining and Milling Methods at the Big Jim Mine, Oatman, Ariz.: Inf. Circ. 6824, Bureau of Mines, 1935, p. 1.

24/ Moore, Roy W., Mining Methods and Records at the United Eastern Mine: Trans. Am. Inst. Min. and Met. Eng., vol. 76, 1928, p. 56.

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In May 1935 an overhand open-stope method was being used to mine an ore shoot 3 to 4 feet wide in a parallel fracture in the hanging wall and 12 feet from the main vein.

Mining costs in April 1933 are shown in table 11.

TABLE 11. - Mining costs per ton, April 1933, 1,457 tons

Breaking ore	$ 1.522
Tramming	.196
Hoisting	.275
Timbering	.079
General underground	.237
Steel sharpening	.146
Compressed air	.138
Drill steel hose, etc	.047
Total	2.640

The above costs do not include track, drill repairs, tools, miscellaneous supplies, or water. Development is included in the above costs and amounted to $0.91 per ton of ore mined. A total of 85 feet of raising was done at a cost of $15.86 per foot. Total direct costs were as follows:

Mining	$ 1.73
Development	.91
Trucking, contract	.30
Milling	2.44
	5.38

This does not include office or general expense or miscellaneous supplies on hand when operations began.

Milling. - The ore was treated in the Telluride mill 1 mile distant, the rental cost of which was $0.612 per ton. The mill was in good condition and required but little overhauling. The ore contained no sulphides and consisted of about equal amounts of calcite and quartz; it was resistant to grinding. The gold was in the quartz and unusually fine grinding was required to liberate it enough for cyanidation. The flow sheet of the mill is shown in figure 6.

Grinding was done in cyanide solution, which was drawn from the main storage tank at the rate of 330 tons per 24 hours. About 50 percent of the value recovered from the ore was dissolved in the ball mill. The classifier overflow contained 15 percent solids; it was 80 to 82 percent minus 200-mesh.

No. 1 thickener was 24 feet in diameter and 8 feet in depth; nos. 2 and 3 agitators were 13 feet in diameter and 14 feet in depth. The thickened discharge contained 40 percent solids. No. 1 agitator was 19 feet in diameter and 14 feet in depth. Air for agitation was used under 30 pounds per square inch pressure. About 95 percent of the gold recovered was taken in solution by the time the pulp left no. 3 agitator. Nos. 2, 3, 4, 5, and 6 thickeners were 15 feet in diameter and 10 feet in depth. The thickened pulp discharge contained 50 percent solids.

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Fifty tons of fresh water were added to No. 6 thickener daily; the barren solution from the precipitation section, 180 tons daily, was added to the feed launder of No. 4 thickener. This solution contained 2.2 pounds of sodium cyanide and 2 pounds of lime per ton. Part of the cyanide solution as drawn from the mill storage tank was added to the feed launder at the head of the ball mill and the rest at the lower end of the classifier. The overflow from No. 1 thickener went to Butters clarifier filter in a 11- by 5-½-foot-deep tank and thence to the clear-gold solution tank 11 by 6 feet in depth.

Metallurgical results. - The recovery was 97 to 98 percent. The bullion was 640 parts gold, 300 parts silver, and 60 parts base metal and impurities. The consumption of reagents was as follows:

Sodium cyanide	0.75 to 1 pound per ton of ore
Lime	3.75 pounds per ton of ore
Zinc dust	8 pounds per day, or 0.7 ounce per ton of ore
Lead acetate	1 ounce per ton of ore

Ball consumption was 2.5 to 4.5 pounds chrome steel to a ton of ore.

Labor. - The mill employed the services of 1 superintendent and assayer, 1 refiner and assayer assistant, 1 crusherman (day shift only), and 6 shiftmen (two on a shift). Experienced men were paid $4.50 and ordinary labor $4 per shift.

Power. - Power cost $0.0267 per kw.-hr. (May 1935). The total installed electric power in the mill was 200 horsepower, divided as follows:

Motor	Horsepower
Crusher	50
Ball mill	75
Main conveyor	10
Apron feeder	5
Compressor	10
Cyanide plant	25
Pumps	25
Total	200

The crusher operated only 5 hours per day and the ball mill at about 70 percent capacity. The average power load was 90 horsepower and power consumption was 30 kw.-hr. per ton of ore milled.

Water. - Water was purchased from a nearby shaft. The cost was $100 per month; for 50 tons of water daily the unit cost would be about 30 cents per 1,000 gallons.

Milling costs. - The milling costs for July 1933 are shown in table 12.

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TABLE 12. - Milling cost, Johnston and Witcher lease on Big Jim mine, July 1933 (1,635 tons milled)

	Labor		Electric power		Water		Lime		Miscellaneous chemicals		Cyanide		Zinc	
	Total	Per ton	Total	Per ton	Total	Per ton	Total	Per ton	Total	Per ton	Total	Per ton	Total	Per ton
Assaying[1/]	$283.00	$0.173	$10.15	$0.006	.....	.....	.....	.....	$20.11	$0.012	.....	.....	.....	.....
Crushing	140.13	.086	30.43	.018	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Grinding	393.88	.241	507.26	.310	.....	.....	.....	.....	29.10	.018	.....	.....	.....	.....
Cyaniding	425.19	.260	456.54	.279	$78.61	$0.048	$116.51	$0.071	4.91	.003	$172.62	$0.106	$32.00	$0.020
Repair and replacement	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Refining and marketing	31.50	.019	10.14	.006	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Rental of mill	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Total	1,273.70	.779	1,014.52	.620	78.61	.048	116.51	.071	54.12	.033	172.62	.106	32.00	.020

	Replacement and repair parts		Balls		Fuel oil and lubricants		Insurance and shipping		Mill rental and miscellaneous		Total cost of milling	
	Total	Per ton	Total	Per ton	Total	Per ton	Total	Per ton	Total	Per ton	Total	Per ton
Assaying[1/]	.....	.....	.....	.....	$9.99	$0.006	.....	.....	.....	.....	$323.25	$0.197
Crushing	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	170.56	.104
Grinding	$58.25	$0.036	$130.77	$0.080	2.02	.001	.....	.....	.....	.....	1,121.28	.686
Cyaniding	19.92	.012	.....	.....	4.50	.003	.....	.....	.....	.....	1,310.80	.802
Repair and replacement	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Refining and marketing	.....	.....	.....	.....	10.05	.006	$8.64	$0.005	.....	.....	60.33	.036
Rental of mill	.....	.....	.....	.....	.....	.....	.....	.....	$1,000.00	$0.612	1,000.00	.612
Total	78.17	.048	130.77	.080	26.56	.016	8.64	.005	1,000.00	.612	3,986.22	2.437

1/ Cost of assaying includes cost of superintendence.

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Gold Road

This mine was discovered in 1902 and soon after the Gold Road Mining & Exploration Co. was incorporated to work it. According to Schrader,25/ 180 men were employed on the property in 1908. The mine was sold to the Needles Smelting and Refining Co., a subsidiary of the United States Smelting Co., in 1911. The known ore bodies were exhausted in 1916, and the mine was closed. It was again worked on company account in 1922 and 1923. Some prospecting was done and some ore produced intermittently by lessees in 1926 and 1928 and again in 1929 above the water level, which is at 300 feet.

In May 1935 the mine was being reconditioned by the company and about 1,000 tons monthly was being produced from rehabilitation work, sorting over of old dumps and leasing operations, and trucked to the Tom Reed mill. The mill at the Gold Road had been junked. The mine was being pumped out for the first time since 1917.

As shown in table 1, $7,250,000 had been produced from the mine up to the end of 1931.

Geology. - The Gold Road vein dips about 85° and occupies a fault in latite. It is a stringer lode with a prominent outcrop nearly 100 feet wide in places. The vein filling that occurs in two zones separated by barren latite consists mostly of chalcedonic quartz. Most of the ore mined has come from three shoots on the north strand of the vein. The largest shoot was 900 feet long by a maximum width of 22 feet and extended from the surface to the 700-foot level. The Sharp ore body, which was 600 feet to the southeast, was mined from the 300- to 500-foot levels and on the 800-foot level. The Rice ore body, about 200 feet farther southeast, was 400 feet long and occurred between the 300- and 500-foot levels. The Lime Road shoot was higher up the mountain and several hundred feet above the Rice ore body. Most of the ore was from 2 to 10 feet wide and occurred between good walls. According to Schrader, the ore mined in 1908 ran $10 to the ton.

Mining. - The mine has been developed to a depth of 800 feet by two shafts, an adit, and levels at the 300-, 500-, 600-, and 700-foot levels.

In May 1935 a plan for one year's development was in force. Two drifts on the vein in virgin territory were being run and the old workings were cleaned out as the water was lowered.

The main oreshoots have been worked by the shrinkage method of mining. Most of the new production in May 1935 came from leasing operations in open cuts on the outcrop of the Lime Road shoot and from development work. The Lime Road ore would have to be trucked in any event either to a custom mill or a new mill should development show enough ore to justify building one on the property. (Recent reports from the Kingman district state it is known from authentic sources that the results of development have justified the erection of a 300-ton mill.) An old shrinkage stope left in 1906 was also being pulled. At the old price of gold it did not pay to hoist this.

25/ Work cited (see footnote 3).

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The cut-off point of the ore in the early workings was 0.3 ounce of gold. With gold at $35 per ounce, material of this grade would be worth $10.50 per ton and could be worked at a profit. It was expected that a part of the vein between the old stopes can now be worked.

Plans for further stoping call for open stopes, shrinkage, and cut-and-fill methods; the method to be used at any one place will depend upon ground conditions and the need for selective mining.

Milling. - The old mill originally had a capacity of 200 tons daily, which was increased to 400 tons toward the end of its life. The ore was cyanided; grinding was done at first with Huntington mills and later with ball mills. Water for milling was pumped from the mine and from a well at Little Meadows on the east slope of the range.

Ruth-Rattan

In May 1935 the Oatman Eastern Mining Co. was mining 1,200 tons per month (30 days) from this mine and shipping it to the Tom Reed mill. Fourteen men were employed.

Prior to 1907 several hundred tons of ore had been taken from the mine and were milled at Hardyville. The mine was worked during the Oatman boom; a shaft was sunk, levels were run, and a stamp mill with electro-amalgamation was built. According to Ross Barkley, mine superintendent, about 25,000 tons were mined on the 100-foot level and milled. The ore body was cut off by a fault. The tailing from the old mill contains $1.70 per ton (gold at $20 per ounce).

In 1933 Barkley and two partners obtained a bond and lease on the property, found the ore on the other side of the fault, and during 1933 and 1934 shipped $25,000 worth of $14.70 ore to the Tom Reed mill. A shipment of 100 tons was made soon after the property was taken over from above the 100-foot level near the shaft. The option was turned over to the present company in 1935.

Geology. - The country rock is porphyry. The vein filling is breccia, calcite and quartz; the dip is 60°. The vein is cut by a fault that crosses the shaft at a sharp angle. The part of the ore shoot mined at the time of the Oatman boom was 3 to 5 feet wide and 86 feet long.

The ore shoot opened up by the present operators averages 12 feet in width on the 200-foot level; the range is 8 to 15 feet. In May 1935 it had been drifted on for 150 feet; a 6-inch streak of ore in the face assayed $50 per ton in gold.

Shipments from development and stope preparation during the first 3 months were as follows: February, 500 tons at $9.45; March, 900 tons at $13, and April, 1,200 tons at $14.

The ore shoot directly above on the 100-foot level is 80 feet long; it was stoped to a width of 3 feet. On the 500-foot level the vein pinches to 2-½ feet.

Mining. - The mine is developed by a 60° incline shaft and drifts on the 100-, 200-, and 300-foot levels. In May 1935 over 600 feet of drifting had been done.

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The mine had but one entrance. Ventilation was supplied through 10-inch galvanized-iron tubing with a branch line into the new stopes on the 200-foot level.

In May 1935 the equipment consisted of a 40 horsepower gasoline hoist, a 309-cubic foot compressor run by a 50 horsepower gasoline engine, and a no. 5 fan run by a gasoline engine. Mining done during the Oatman boom and by Barkley was by open-stope methods.

In May 1935 preparations were being made to mine the ore on the 200-foot level by a shrinkage stope, but the chutes had not been built.

Water was bailed from the shaft just below the 200-foot level with a 1,000-pound bucket. The water in the shaft was lowered 20 feet in 6 hours of bailing and came back in 15 to 18 hours.

Costs. - Gasoline cost 10 cents a gallon delivered (without State tax). The gasoline bill for April 1935 was $350. The wage paid in May 1935 was $5 for all workmen except the hoist engineer, who received $6 per day. Mine costs in April 1935 were $3.50 per ton.

Mossback

The Mossback mine is about 7 miles northeast of Oatman in rolling country at an elevation of 2,400 feet. The Mossback claim was located in 1863. Prior to 1907 the mine was developed by a 330-foot shaft, in which the water stood at the 170-foot level. The shaft was sunk to the 800-foot level in 1918 and 1919. M. B. Lauzon worked the mine from 1927 to 1935 under a lease and bond from the Empire Consolidated Gold Mining Co. The Mollin Mining Co. became interested in the mine in May 1935 and began development work which continued until the end of the year. On his last inspection in 1935 the State mine inspector reported 14 men employed.

Geology. - The Mossback vein is in andesite and up to 90 feet wide; it dips at 80°. The vein filling consists of brecciated andesite and calcite with a subordinate amount of quartz. A 65-foot crosscut on the 300-foot level and a 164-foot drift on the 400-foot level disclosed calcite throughout. The gold occurs in fractured areas in the veins; the ore is bunchy, and values are spotty. An irregular ore shoot with an average cross section of 14 by 20 feet corkscrews upward on the 400-foot level. Eighty-six tons from this shoot milled $12.88 ($35 gold) per ton in gold. A total of 435 tons of ore taken from the 65-foot crosscut averaged $10.85 in gold per ton.

Production. - The mine is credited with no production up to 1933, during which year Lauzon mined and milled 200 tons. A 15-ton mill was run intermittently up to the spring of 1935. Lauzon reports a gross production of $15,000 in gold prior to May 1935. From May to December 1935, 1,309 tons of ore containing an average $7.14 in gold per ton was produced from development work.

Development. - The mine is developed by an 80° incline shaft and 2,000 feet of drifts and crosscuts. Work from 1932 to 1935 was done on the 400-foot level and the levels above. During 1935, 325 feet of development work was done on the 500-foot level in addition to work above.

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Equipment. - The mine equipment in May 1935 consisted of a compressor run by a 75- horsepower gasoline engine and a 40- horse power gasoline hoist. An auxiliary 7 ½- by 6-inch compressor also was run by the hoist engine. The hoisting equipment had a capacity of 25 tons per 8 hours.

Stoping. - No systematic stoping had been done up to the end of 1935. The small ore shoots that had been found had been gouged out as open stopes. In March 1933 a stope 8 feet wide and 15 feet high was being worked near the shaft on the 400-foot level. The ore was broken down in benches or by rounds drilled from the top of the pile of broken ore. Drilling was done with either a stoper or mounted drifter. Eighty-eight tons of ore were stoped by one man in 15 shifts. Sixty-four holes that averaged 4-½ feet deep were drilled in eight shifts; seven shifts were required to do the shoveling and tramming. No deadwork or sorting was done. One hundred thirty-four buckets of 1,300 pounds each were hoisted. The direct cost was as follows:

	Amount	Per ton
Labor, mine, 15 shifts at $4.50		
Hoist engineer, 5 shifts at 4.50		
Total labor, 20 shifts.....	$90.00	$ 1.02
73-½ pounds explosive at 15 cents...	11.02	
Fuse, 330 feet at 1 cent.....	3.30	
Caps, 65 at 3 cents.....	1.98	
	16.30	.19
Fuel, 110 gallons at 6 cents.....	6.60	.08
Other supplies.....	8.80	.10
Total.....	$ 121.70	$1.39

Milling. - A mill equipped with a jaw crusher, Hardinge ball mill, and amalgamation plates was used in 1933. In the latter part of the year a mill of 15 tons daily capacity was rebuilt. The mill was started when enough ore for a run had accumulated in the bins. The flow sheet was rearranged in 1934 as shown in figure 7. The mill as remodeled by the Mollin Mining Co. is shown in figure 8.

The ore was stored at the collar of the shaft in a 60-ton bin divided into two compartments of 40 and 20 tons capacity, respectively.

A 1-inch grizzly, 30 inches wide and 12 feet long, was set over the larger compartment; the undersize fell into a mine car. About one-eighth of the ore passed through the grizzly. It was stated that the fines generally were much lower grade than the coarse; they were either milled or dumped on the waste pile, according to the need for ore and their probable value.

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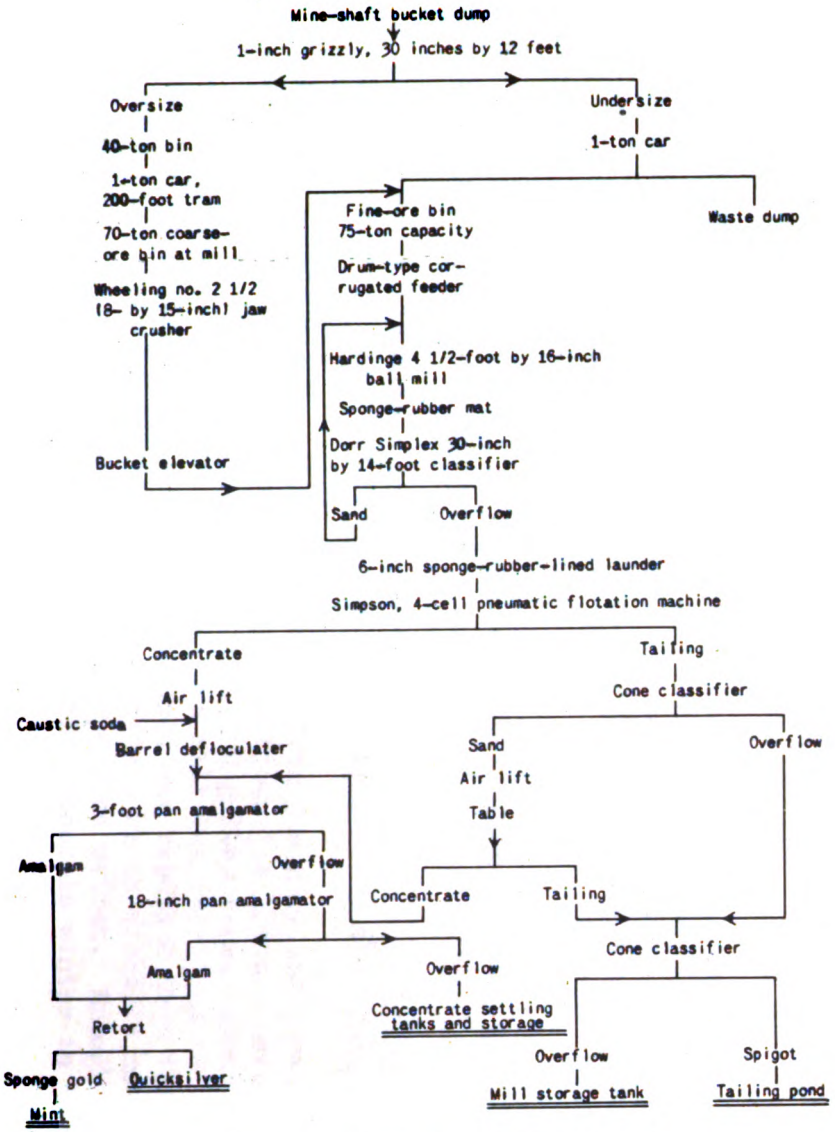

Figure 7.- Mill flow sheet, Mossback mill, 1934.

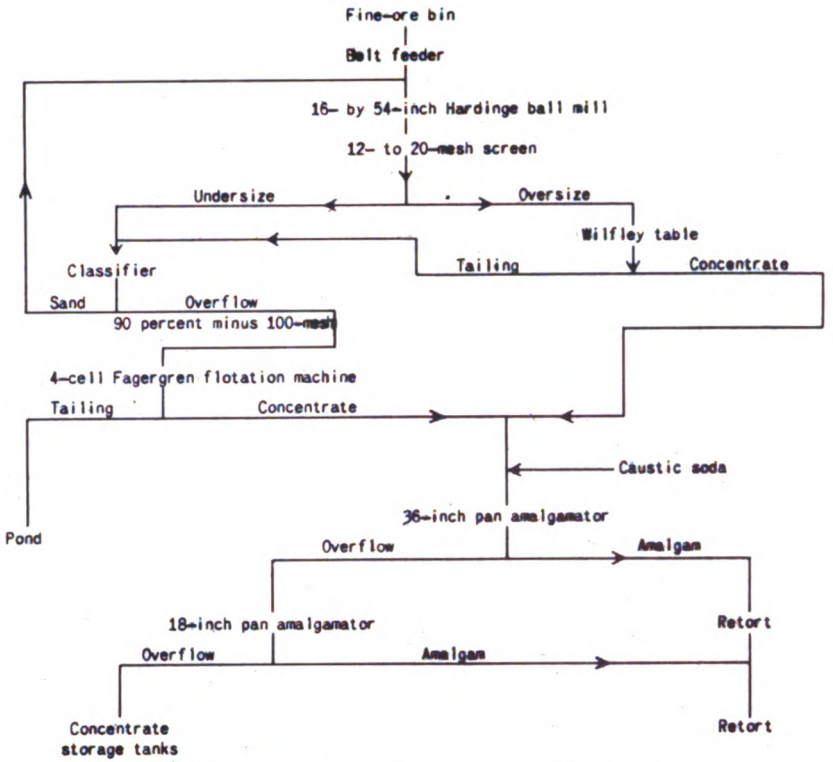

Figure 8.- Mollin Mining Co. flow sheet, Mossback mill, 24 tons per day.

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From the fine-ore bin a belt feeder fed the ore to a 4½ foot by 16-inch Hardinge conical ball mill turning at 33 to 34 r.p.m. The ball mill was run by a 40-horsepower motor; the actual load was about 25-horsepower. The ball mill was said to have a capacity of 1 ton per hour on ore from near the surface but only about 0.8 ton per hour capacity on ore from the 400-foot level, which contained a higher proportion of quartz to calcite. The classifier was set at a slope of 2-3/8 inches in 12 and was run at 26 strokes per minute. The classifier overflow was about 95 percent minus 65 mesh.

The sponge-rubber mat under the ball-mill discharge was washed off in a tub of water every 2 hours, and the rubber lining of the flotation-feed launder once each day; these concentrates were treated in a large pan amalgamator. About 50 percent of the gold content of the ore was caught on the sponge-rubber and the rubber mats.

Several combinations of flotation reagents had been tried. From 0.01 to 0.02 pounds of American Cyanimid reagent No. 301 per ton of ore was added in the classifier. Copper sulphate was added at the rate of a teaspoonful every 15 minutes. Ammonium phosphate added at about the same rate was believed to improve silver recovery appreciably. P. E. collector (Southwestern Engineering Co.) was being added in the ball mill and pine oil in the flotation-feed launder at the time of the visit, but this combination was said to be less effective than a previous use of Aerofloat no. 15 (0.005 lb. per ton of ore) and American Cyanimid B 22 frother (an alcohol). The latter gave a brittle froth and, being nonoily, did not interfere with amalgamation. Air at 3 pounds per square inch pressure for the flotation cells was supplied by a small blower. A finished concentrate was taken from the first three cells, the froth from the fourth cell being returned to the head of the machine.

The flotation concentrate was raised by an air lift to a tank made of a steel barrel, where a very small stream of saturated solution of caustic soda was added to break down the froth. The overflow from the barrel passed by gravity to the larger of two pan amalgamators, thence to the smaller, and finally to a settling tank. The concentrate was stored for future treatment or shipment to a smelter.

The amalgamators were said to be removing 60 percent of the gold from a 5-ounce feed, leaving a shipping product assaying about 2 ounces of gold per ton.

The scavenger table made a small quantity of concentrate containing 1.5 ounces of gold per ton; this was fed periodically by hand to the amalgamators.

Mill water supply came partly from pumping from the mine and partly by gravity through a pipe line from a spring in the foothills about 2 miles away. The mill water was stored in a 24,000- and a 11,000-gallon tank. About 8,000 gallons of fresh water was needed daily when the mill was operating two shifts. From 20 to 25 percent of the water in the tailings was returned from the dewatering cone to storage by a centrifugal pump driven by an electric motor that was turned on and off automatically by a float-operated switch. Enough water is available to treat 15 tons daily in summer and 25 tons in winter in the mill with the new flow sheet (fig. 8).

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Amalgam was retorted over a wood fire and the sponge shipped to the mint without melting or refining. Although the ore contained about equal weights of gold and silver, the mint return showed only 1 ounce of silver to 3 of gold in the bullion.

Power for operating the mill was purchased from the public utility company. The mill required an operator on each shift. The toplander at the mine tended to the crushing on day shift. No operating data are available for the mill after the flowsheet was changed, as shown by figure 8, except that two-thirds of the recovered gold was in the amalgam.

Pioneer or German-American

The Pioneer, formerly called the German-American, mine is 1-½ miles southwest of Oatman in the foothills of the main range. The Gold Roads Co. did some work on the property in 1902. During 1903 to 1906 the German-American Mining Co. produced 2,700 tons of ore that averaged $10 per ton in gold. In 1925, 312.4 tons of ore with a value of $6,051 was produced by lessees from the property.[26]

In May 1935 the property was held by the Amulet Mines, Inc., and was worked by 12 sets of lessees (23 men). Between 400 and 500 tons was mined monthly. The ore was treated at the Tom Reed mill, the value ranging from $16 to $35 per ton; the average was a little over $16.

Geology. - The Pioneer vein, which also goes through the Treadwell and 35th parallel patented claims, dips 80° to the east. The hanging wall is Oatman andesite, and the footwall for 2,000 feet is trachyte. The vein intersects the Gold Dust-Boundary Cone fault at an angle of 40° but neither vein is offset by the other. The maximum width of the vein is 18 feet, at a point near the Pioneer shaft. The vein material here is coarsely grained gray calcite and quartz.

Several small ore shoots were mined near the southern end of the Pioneer vein. One of them, near the Treadwell shaft, was 400 feet long and 3-½ feet wide. The ore consisted of quartz and calcite. At the Pioneer shaft near the northern end of the property narrow parts of the vein assayed more than $10 (at $20 gold) and yielded some rich ore near the surface.

The vein is strong to the 400-foot level, where developed, but no ore has been mined below the 200-foot level. Most of the ore produced is along a slip in the vein. A number of small ore shoots up to about 40 feet in length occur along the Pioneer vein at the surface.

Development.[27] - The underground development is as follows:

Pioneer No. 1 shaft: 420 feet deep with 400-foot drift on 100-foot level, 1,160 feet of drifts and crosscuts on 200-foot level, and 1,230 feet of drifts and a 70-foot winze on 400-foot level.

26/ From report on mine by Geo. F. Moser, Oatman, Ariz.
27/ Moser, Geo. F., work cited (see footnote 26).

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Pioneer no. 2 shaft: 50 feet deep with short drifts.

Treadwell shaft: 340 feet deep with 405 feet of drifts on 100-foot level, 150 feet of drifts on 200-foot level, and 25 feet of drifts on 300-foot level.

35th Parallel shaft: 220 feet deep, with connection with adit on 150-foot level and two raises to surface.

Snowball shaft: 90 feet deep.

In addition numerous open cuts have been dug on the property.

Equipment consists of a 22-horsepower gasoline hoist and 300-cubic foot compressor run by an 80-horsepower gasoline engine at no. 1 shaft.

Mining. - The ore produced in 1903 and 1906 was mined underground in open stopes. The work being done by lessees in 1935 was in open cuts or from shallow shafts that had been sunk by the lessees. The leases were at the surface for blocks of ground beginning at the surface along the Pioneer vein and on sections of other veins on the property. The leases being worked in May 1935 were verbal only. The royalty charged is shown in a previous section under the heading "Royalties." The methods used are shown in the following representative leases.

Ferra lease on Treadwell claim. - E. J. Ferra and three partners started work in November 1934 and began shipping in January 1935; up to May 1935, 270 tons running about $14 per ton had been shipped to the Tom Reed mill.

The vein at this point is about 4 feet wide. The vein filling is calcite with some black hematite. The ore occurs in streaks 6 to 12 inches wide.

A stope was started on the surface and up to May 1935 had been mined underhand over a length of 40 feet and to a depth of 30 feet. A part of the stope is under an old drift run in the vein and partly outside in front of the portal of the drift. About half of the material broken was sorted out and discarded. Control of the grade was obtained by a large amount of panning, all work being done by hand; hoisting was done by means of a hand windlass.

Bridges lease on Pioneer: - The lessee found a high-grade shoot of ore in a strand of the main vein at the surface to the south of the no. 1 Pioneer shaft. The first ore was mined in an open-cut and from a short adit. In May 1935 he was mining underhand below the floor of the adit at a depth of 20 feet. Drilling was done with a jackhammer. Air was supplied by means of a small portable gasoline compressor. Hoisting was done in a 300-pound bucket. The hoist consisted of an old automobile with one rear wheel replaced with a small drum. Lowering was done in gear; breaking was done by the compression in the engine. The car was set facing the working.

United Western

The United Western is on the Oatman-Kingman highway and adjoins the United Eastern on the east. According to Frank Waring of Oatman, the mine was operated

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in 1927 and 1928 by the Consolidated Gold Mining Co. About 12,000 tons was produced from the 700-foot level. A little ore also was produced at this time on the 850-foot level through the United Eastern shaft.

From March 1 to May 1, 1935, about 2,000 tons was produced from above the 500-foot level by the same company. The water stands at 560 feet in the western shaft, which was not pumped out. A connection has been made with the United Eastern workings, which was under water during the last operation. At the time of the author's visit only a watchman was on the property.

The ore was treated in the Tom Reed mill 2 miles distant. The trucking charge was $0.35 per ton. The ore was loaded from chutes.

The Consolidated Gold Mining Co. also had the Lexington and Del Rey mines. Lessees were working the Lexington.

The vein in the United Western is reported to be a spur of the Tom Reed-United Eastern vein. It is 3 to 12 feet wide, averaging 6 feet. The vein material is massive calcite with a little quartz; the values occur mostly with quartz. Development work consists of a 735-foot shaft with levels at 300, 500, and 700 feet. The 850-foot level, which connected with the United Eastern workings, was reached by a winze from the 700-foot level.

Lexington. - The Lexington mine is 2 miles west of Oatman at Tex's Camp. A little ore was shipped in to the Tom Reed mill during the summer of 1934. In May 1935 four lessees were working in the mine but had not begun to ship. The mine is developed by a 375- and a 200-foot shaft connected on the 250-foot level of the deeper shaft. The vein is reported large, the ore hard, and the walls soft. The ore occurs in small bunches in the vein; that shipped in 1934 averaged about $9 per ton.

Telluride

The Telluride mine adjoins the Tom Reed on the south. It was active from 1922 to 1925 and was operated in a small way from 1930 to 1934. The estimated production to the end of 1933 was about $200,000. In May 1935 140 tons per month were being mined by the Oatman Associates Mining Co. and trucked to the Tom Reed mill for treatment. The mill, which was built to treat the Telluride ore, was under lease to Johnston and Witcher. The Oatman Associates Mining Co. started development work in January 1934. Shipments, starting with 35 tons per month, were begun in January 1935.

The Telluride vein, which joins the Tom Reed vein south of the Ben Harrison shaft, has an inconspicuous outcrop and is about 3,000 feet long. The vein is about 3 feet wide. An ore shoot 200 feet long on the 300-foot level was being worked in 1935. The ore consisted of 4 to 10 inches of calcite (no quartz) frozen on the hanging wall. Production has been between the 300- and 500-foot levels. Some development work was being done on the 700-foot level, but the vein was too low grade to mill.

The mine is developed by a 700-foot shaft and four levels. It is connected with the Tom Reed underground.

In May 1935 a cut-and-fill method of stoping was being used. The stoping width was 3 feet - the distance between walls.

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Midnight

The Midnight mine is 2-1/7 miles northwest of Oatman. A moderate production was made between 1900 and 1907. The property was then idle until 1935, when Hautier and Waters began leasing operations. Up to May 165 tons, which averaged $17 per ton, was shipped to the Tom Reed mill. It is reported that some ore from this mine was milled in the Leland mill after that mine closed down in 1904.

The Midnight vein, which is the footwall member of a wide lode, dips 45° to the west. It occurs in the Oatman andesite and probably also in trachyte. The vein filling consists of quartz, calcite, and fluorite. Development work consists of a 300-foot 45° shaft with three levels.

The hoist was run by an old automobile engine, and the ore was hoisted in a 600-pound bucket. Three and one-third gallons of gasoline was used per 8-hour shift. Compressed air was supplied by a 120-cubic foot portable compressor. A rental of $75 monthly was paid for the compressor; these payments, however, could be applied on the purchase price.

The old mining was done underhand from the 50-foot level. The present work is underhand from the 100-foot level. A crosscut was being run in May 1935 to get the junction of two leads where an ore shoot was expected.

Principal Nonproducing Mines, May 1935[28/]

Moss. - The Moss mine is about 7 miles northwest of Oatman and 2 miles north of Silver Creek. It was one of the first mines to be worked in the Black Mountains. About $240,000 in gold was produced in the early days. Since that time considerable intermittent development work has been done but little ore has been mined. The vein, which can be traced for over a mile on the surface, dips 80° to the south, is 20 to 100 feet wide, and occurs in quartz-monzonite-porphyry. The vein filling consists of fine-grained white quartz and calcite with stringers of fluorite. The principal ore shoot extended to a depth of 65 feet.

Development workings include a 230-foot shaft with about 750 feet of drifts and crosscuts, about a 900-foot adit, and irregular surface openings. Ransome states that the vein on the 220-foot level appears to be 90 feet wide and carries from 0.15 to 0.2 ounce of gold to the ton.

Gold Dust. - The Gold Dust, formerly known as the Victor-Virgin and the Orion, is about 1 mile southeast of the Ben Harrison shaft. The property, which was located in the early days, produced a small amount of shipping ore prior to 1907. Some ore was produced in 1923, 1926, and 1932.

The vein consists of solid quartz and calcite with a width up to 7 feet. It splits to the northwest into a series of small stringers. Two ore shoots were mined, the largest having a length of 200 feet and extending from the surface to a depth of 160 feet. The mine has been developed to a depth of 500 feet.

Leland. - The Leland mine is about 2 miles west of Oatman and was one of the early mines worked in the district. Some high-grade ore was produced in 1902. In 1903 a 17-mile railroad was built and a 40-stamp mill erected at Milltown about one-half mile from the Colorado River. The venture proved unsuccessful, and the mine was closed in 1904. It is reported that $40,000 was produced from 4,500 tons of ore.

28/ Abstracted from Wilson, work cited (see footnote 4).

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Two veins, the Leland and the Mitchel, occur on the property. The vein filling consists of quartz and calcite. It is reported that a large tonnage of $3 to $4 ore (at $20 gold) has been indicated.

A shaft over 700 feet deep has been sunk on the Mitchel vein.

Sunnyside. - The Sunnyside mine is about 1-½ miles southwest of Oatman at the edge of the district. The mine is on a fault. A small ore shoot was mined in 1928 from the 500-foot level. The ore consisted of quartz with a very little calcite. Some production was made by lessees in 1929 and 1930.

Iowa mine. - The Iowa mine is in the southern part of the district about 3 miles south of Oatman. Prior to 1907 it was developed by a 200-foot shaft and 100 feet of drifts. A little further development was done in 1916. The vein occurs in trachyte. Schrader states that gold values occur in a 3-foot width adjacent to the hanging wall.

Hardy. - The Hardy mine is about 5 miles northwest of Oatman. It is reported to have yielded rich ore near the surface during the early days. Prior to 1907 it was explored to a depth of 300 feet by several shafts, over 1,200 feet of drifts, and several hundred feet of adits. The vein, which occurs in granite porphyry, ranges in width from 2 to 30 feet. The vein filling is quartz, calcite, and fluorite.

Gold Ore. - The Gold Ore property, about three-fourths mile northeast of the Gold Road mine, has had some small production at various times from 1918 to 1926. The country rock is latite. The vein occurs in a fault fissure; the dip is 82°. The vein material is mostly quartz. The mine is developed by an 800-foot shaft with levels at 100-foot intervals. The ore mined has come mostly from between the 300- and 600-foot levels.

Katherine or Union Pass District

The location of the principal mines in the Katherine district is shown in figure 1. The geology is shown in figure 9 (from Lausen).

Gold Standard Mines Corporation

The Katherine mine and mill are 1-½ miles east of the Colorado River and 33 miles from Kingman. The collar of the shaft is 990 feet above sea level and 450 feet above the river. The water table in the shaft is at the 350-foot level.

As stated in the chapter on "History," the Katherine mill and water rights were purchased by the Gold Standard Mines Corporation in 1933. The company also acquired the Roadside and Arabian Mines at that time and later the Minnie and Frisco.

The Minnie-Sheeptrail-Boulevard group was reported under lease in May 1935. The Portland, up the river, about 12 miles as the crow flies was acquired late in 1935. Ore from the Roadside, Arabian, Minnie, and Frisco, together with custom ore, was being treated in the Katherine mill in 1935. In January 1936 the development ore shoot at the Roadside had been exhausted, and the mine was closed.

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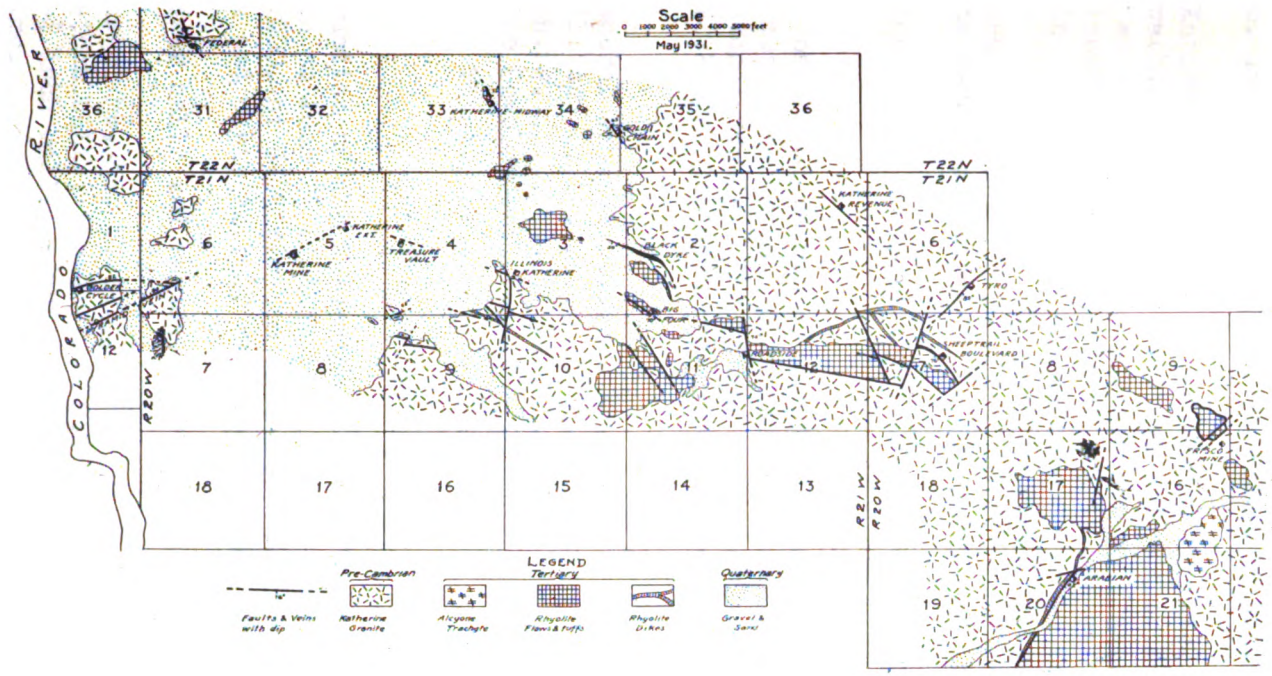

Figure 9.- Geologic map of the Katherine district.

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At that time about 100 tons daily was being shipped from the Portland, 60 tons of custom ore was being received from the Tyro, and the remaining tonnage required to bring the mill up to capacity came from the Arabian (or adjoining Philadelphia), Minnie, and Sheeptrail mines.

Katherine mine. - The Katherine mine and mill were being operated by the Katherine Gold Mine Co. in 1927; it has been described by Dimmick and Ireland.[29]

The vein at the Katherine occurs in pre-Cambrian granite, which is largely buried under surface wash. It is nearly vertical and consists of a stringer lode that is about 60 feet wide at the surface but narrows underground. The vein filling consists of closely spaced stringers of quartz and calcite in the granite. At some places the vein is solid quartz and calcite up to 10 feet thick; the quartz is more abundant than calcite. The gold is finely divided in the quartz. The lode has been opened to a depth of 900 feet and for 1,700 feet along the strike. The ore shoots were found between the 400 level and the surface.

The mine is developed by a 900-foot shaft with levels at 100, 200, 300, and 400 feet.

Shrinkage was the principal method of stoping followed; when the walls were weak the cut-and-fill method was used. Shrinkage stopes 700 feet long and 200 feet high were worked successfully. The mining cost was $1.50 per ton with shrinkage stopes and $2.25 per ton with cut-and-fill stopes. The total cost of operation was:

General expense.....	$0.59
Milling.....	1.11
Mining.....	1.63
Mine Development.....	.62
Total.....	3.95

Katherine mill.

History. - Construction of the Katherine mill was begun January 1, 1925, and it was put in operation on June 29 of that year. The cost of the mill as it stood in 1927 was $95,000, or $365 per ton of daily capacity (260 tons). The metallurgical data and costs in 1927 reported by Dimmick[30] follow.

Consumption of power balls and reagents per ton of ore was:

Power, kw.-hr.	16.0
5-inch balls, pounds....	2.0
2-½ inch balls, pounds..	2.2
Lime.....	3.0
Water, ton.....	.62
Zinc dust per ton solution, pounds.....	.07

29/ Dimmick, R. L., and Ireland, Eugene, Mining and Milling at the Katherine Gold Mine: Eng. and Min. Jour., vol. 123, April 1927, pp. 716-720.
30/ Work cited.

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The ore was ground to 57 percent minus 200-mesh. The tailing loss averaged $0.15 per ton of ore of undissolved gold and $0.045 for dissolved gold. Milling costs were:

Labor	$0.359
Supplies	.462
Power	.291
Total	1.112

The mill was shut down in 1930; it was reopened for a short time in 1932 and 1933 but soon closed again for lack of ore. E. F. Nieman and associates purchased the Katherine mill from the Federal receiver soon after it closed, formed the Standard Gold Mines Corporation, and began to ship ore from their Roadside mine on November 13, 1933.31/ One year later a fire wiped out the crushing plant, power house, ore bin, head frame, and timber of the Katherine shaft down to the water level. The fire started in the Diesel plant the day before it was planned to cut in electric power from the Utility Co. The plant was again put in operation on November 26, 1934.

Ore treatment. - Standard countercurrent cyanide practice is followed, except that, due to clarifying trouble, the solution from No. 2 thickener rather than No. 1 thickener goes to the precipitation plant. In May 1935 from 230 to 250 tons per day were being treated. The flow sheet of the mill as it was at that time is shown in figure 10.

The decantation system consists of four Dorr and one Hardinge superthickeners at the end of the line. Two 4-inch Dorrco pumps are used on each tank. An auxiliary gasoline engine is installed to supply power to the agitators should the electric power go off. Water is added to the tails for sluicing them to a tailing pond.

The ore was in contact with cyanide solution 48 hours. The mill was cleaned up weekly.

Water. - Water is pumped through a 5-inch pipe from a well sunk at the edge of the Colorado River 2 miles distant. The rise in elevation is 445 feet. An average of 100,000 gallons was pumped daily in May 1935 on a 10-hour shift. The supply for the mill and camp is stored in three 18,000- and two 32,000-gallon tanks.

Power. - Power is purchased from the public utility company at Kingman by way of the Moss mine. It is conducted at 44,000 volts and stepped down to 440 volts at the mill. Three 150 kv-a transformers are at loaded capacity. Over 500 horsepower is used in the mill. The average rate is 2 cents per kw.-hr. The motor set-up in the crushing and grinding plant is as follows:

31/ Banks, Leon M., Gold Mines at Katherine: Explosives Eng., May 1935, p. 147.

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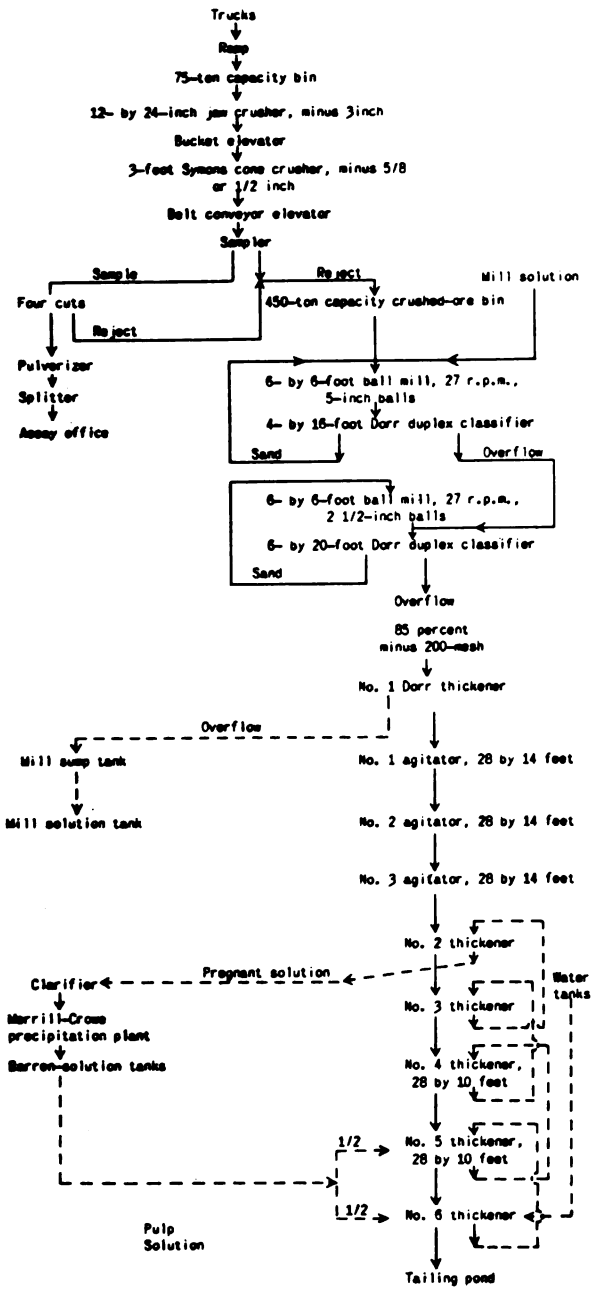

Figure 10.- Flow sheet, Katherine mill.

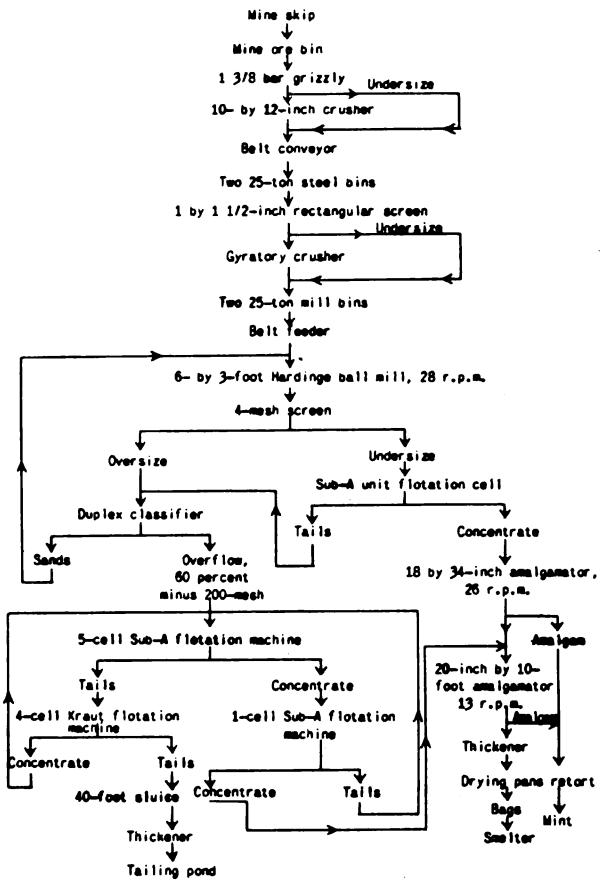

Figure 11.- Flow sheet, Pilgrim mill, capacity 75 tons per day.

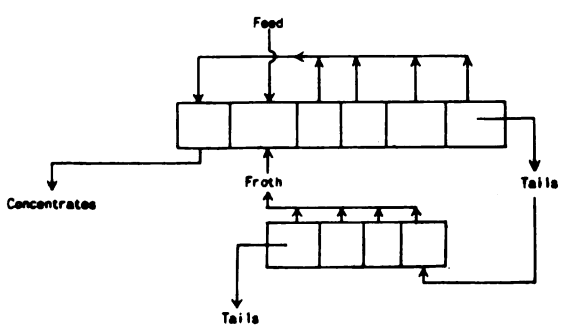

Figure 12.- Flotation circuit, Pilgrim mill.

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	horsepower
Crusher	40
Symons	60
Primary ball mill	125
Secondary ball mill	125
Belt conveyor	10
First Dorr classifier	2
Second Dorr classifier	5
Bucket elevator	5
Sampler:	
Rolls	20
Other sampling equipment	3
	23
Total	395

The motor set-up in the cyanide plant is as follows:

Agitators and two 5-horsepower pumps	10	
Thickener and first agitator	5	
Second thickener	5	20
Air compressor, 12- by 14-inch		50
Water-supply pump		50
Total		120

The motors on the solution pump in the gold room are as follows:

Centrifugal circulation pump, 3.7 1/8 horsepower	22½
Triplex solution pump	10
Vacuum pump	3
Vacuum pump	2
Total	37½
Grand total	552½

Metallurgy. - In March 1934 95 percent of Arabian ore and 92 percent of Tyro ore were recovered. Tyro ore is harder and is not ground as finely as the other. Silver recovery was 50 percent.

The reagent consumption was as follows:

Cyanide consumption, Aerobrand	2 pounds per ton
Lime consumption, cold weather	5 pounds per ton
Lime consumption, hot weather	3 pounds per ton
Zinc	25 pounds daily

The Tyro ore requires more lime than the Arabian. The ball consumption was 3½ pounds per ton of ore.

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Mill labor, May 1935. -

Mill and crusher men	10
Foreman	1
Assayer	1
Assayer's helper and sampler	1
Scale and warehouse	1
Blacksmith	a/ 1
Master mechanic	a/ 1
Watchman	1
Clerk	1/2

a/ Also does work for mine.

The scale for mill men in May 1935 was $4.50 per 8-hour shift.

Milling cost. - Chemicals cost 30 cents per ton. The milling cost in 1935 was as follows: Direct, $1.76; indirect, 64 cents; total, $2.40. Power cost was $0.49, chemicals, $0.30, and labor $0.22 per ton.

Roadside mine. - The Roadside mine is on the Kingman-Katherine road about 4 miles east of the Katherine mill.

The present shaft was sunk to the 100-foot level in 1915 and 1916 and later extended to the 300-foot level. It has two compartments and is at an incline of 70°. Up to January 1934 the Gold Standards had done about 1,000 feet of development work on the 100-foot level and produced 890 ounces of gold and 1,734 ounces of silver. In May 1935 the last of the ore from a shrinkage stope was being drawn; in January 1936 the mine was closed.

The country rock is granitic gneiss. The vein dips 33° to 38° and is in a fault zone in a block of rhyolite against a fault. The vein material is irregular stringers and bunches of quartz and calcite in shattered silicified rhyolite. A chimney-shaped ore shoot with a flat rake to the north extended from the surface to the 100-foot level. It was 20 to 35 feet wide and 75 feet long on the strike. According to Banks,[32] the ore averaged 0.28 ounce of gold to the ton.

Despite the flat dip of the vein, the ore was mined by a shrinkage method. In March 1934 about 10,000 tons had been broken, but only the swell had been pulled. Plans called for using a scraper for emptying the stope.

Chutes were 25 feet apart with pillars left between them. Although only a few pillars were left in the stope, no caving of the back occurred.

In the spring of 1935 the ore was being mined by one machine miner, two men with hammers in the stope, two trammers on the 50-foot level, one bucket loader, and one topman. Hoisting was done in a 1,000-pound bucket and tramming in 16-cubic-foot cars running on 18-gage track. The water was kept down in the shaft by pumping two shifts each day with a boiler-feed pump.

The mine equipment consisted of a 20-horsepower gasoline hoist and a 10- by 12-inch compressor driven by a 40-horsepower gasoline engine. An old automobile engine was belted to the compressor engine for starting purposes.

32/ Work cited (see footnote 31).

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The costs for the 4-month period, November 1933 to February 1934, are shown in table 13. The costs shown in the table are apparent rather than actual. A reserve of broken ore was built up in the stope, to be drawn later and on which the breaking cost had been charged out.

According to Banks,33/ the cost for the 6 months preceding the fire of September 1934 was $2.15 a ton delivered in the surface bin.

TABLE 13. - Cost of mining 3,278.15 wet tons (3,186.14 dry tons), Roadside mine, November 1933 to February 1934

Item	Material	Labor	Total	Per dry ton
Supervision	.....	$1,200.00	$1,200.00	$ 0.377
Mining	$1,119.88	2,785.34	3,905.22	1.226
Mucking	6.11	1,062.23	1,068.34	.335
Compressed air and hoisting	711.76	900.10	1,611.86	.506
Equipment and repairs	126.31	.....	126.31	.040
Carbide	24.00	.....	24.00	.008
Blacksmithing	65.51	210.05	275.56	.086
Pipe fittings	13.29	.....	13.29	.004
Sampling and assaying	113.51	477.07	590.58	.185
Trucking	213.77	171.36	385.13	.121
Miscellaneous	511.24	.....	511.24	.160
Insurance	.....	278.28	278.28	.087
Total	2,905.38	7,084.43	9,989.81	3.135
Cost per ton of ore	0.912	2.223	3.135	.....

Arabian mine. - The Arabian mine is on the Kingman-Katherine road about 8 miles from the Katherine mill. Intermittent work has been carried on at the mine since before 1917. It was taken over by the Gold Standards late in 1933. The 1933 production amounted to 593 ounces of gold and 1,156 ounces of silver.

The country rock is granite in which a rhyolite-porphyry dike has been intruded. Rhyolite tuffs have been faulted against the hanging-wall side of the dike. The Arabian vein occurs in the dike close to the fault; the dip is 82°. A portion of the dike south of the underground workings occurs as a bold outcrop. Between 60 and 70 feet of the outcrop next to the hanging wall is reported to run 0.10 to 0.11 ounce of gold to the ton.

A mineralized zone 30 feet wide, consisting of a number of quartz stringers, occurs in the dike and to some extent in the granite footwall. A shaft on the north end of the property has exposed a stringer vein 3 to 8 feet wide that contains 0.25 to 0.40 ounce of gold to the ton on the 80-foot level.

Development work consists of a 280-foot shaft with levels at 80 and 180 feet. The shaft and ore shoot dip at 53°. Most of the ore is above the 100-foot level and comes to the surface in contact with the gravels in the wash as the hanging

33/ Work cited (see footnote 31).

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wall. In March 1934 a shrinkage stope 125 feet long was being worked from above the 80-foot level. Chutes were 25 feet apart. Triangular pillars 15 feet long and 10 feet high were left between the chutes. Three manways built of stulls with outside lagging were maintained in the stope. Except for the manways and chutes, no timber was used.

In May 1935 drifting and crosscutting were being done to get under the shoot on the 180-foot level, and the upper portion of the ore shoot in contact with the gravels was being mined. About 50 tons per day, including development rock, was being milled from the underground workings.

The ore was raised in a 1-ton skip by a hoist run by a 25-horsepower gas engine. Compressed air was furnished by a 8- by 10-inch compressor. The ore was dumped into an 18-ton bin at the shaft and then trammed to a 25-ton storage bin.

The underground costs for 4 months, November 1933 to February 1934, are shown in table 14.

TABLE 14. - Cost of mining 4,208.80 wet tons (4,122.69 dry tons), Arabian mine, November 1933 to February 1934

Item	Material	Labor	Total	Per dry ton
Supervision	.....	$1,087.50	$ 1,087.50	$ 0.264
Mining	$1,519.80	1,598.77	3,118.57	.756
Mucking	5.10	1,270.71	1,275.81	.309
Compressed air and hoisting	918.13	1,496.90	2,415.03	.586
Equipment and repairs	449.10	.....	449.10	.109
Carbide	18.00	.....	18.00	.004
Blacksmithing	65.51	228.05	293.56	.071
Pipe fittings	8.00	.....	8.00	.002
Sampling and assaying	113.51	477.07	590.58	.143
Trucking	213.77	171.36	385.13	.094
Miscellaneous	465.92	.....	465.92	.113
Insurance	.....	252.14	252.14	.061
Total	3,776.84	6,582.50	10,359.34	2.512
Cost per ton of ore	0.916	1.596	2.512	.....

Arabian open-cut. - The Arabian open-cut was about one-quarter mile from the Arabian shaft mine. The dike is 150 to 200 feet wide and outcrops for a distance of 700 feet. The hanging-wall side of the vein has been eroded away by a large wash; the dip was 58°. The face originally stood up as a cliff 150 feet high.

Mining was done by breaking 10-foot benches, starting at the top, over a width of 50 to 60 feet. Drilling was performed by two men with jackhammers on one shift per day at a contract price of 20 cents per ton. Air was furnished by a portable compressor. The broken ore fell to the base of the cliff and large pieces were broken up by hand, which cost about 30 cents per ton of ore mined.

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The ore was loaded into trucks on contract at 20 cents per ton by a 1/4-cubic yard, full-revolving power shovel mounted on a tractor. The boom was 14 feet long and dipper stick 12 feet long. The contractor who owned the shovel came out from Kingman each day that ore from the open-cut was wanted at the mill. According to Banks, in December 1934, 100 tons was loaded on alternate days in 4 hours. The trucking cost was 40 cents per ton, which made a total direct cost of $1.10 per ton before milling.

In March 1934 a reserve of several thousand tons was broken ahead of the shovel; in May 1935 the open-cut work had been discontinued.

Minnie-Sheeptrail-Boulevard mine. - The Sheeptrail and Boulevard were the earliest recorded locations in the Katherine district; they are credited with approximately 15,000 tons of ore that was hauled to a mill on the Colorado River prior to about 1906. The Gold Standards Mines Corporation acquired a lease on these two properties and a central one known as the Minnie in 1935. In May 1935 the Minnie was being prepared for production.

A crosscut was run to intersect several quartz-calcite veins that outcrop on the hillside near a granite-rhyolite contact.

In January 1936 lessees had begun shipping from the Sheeptrail to the Katherine mill.

Frisco. - The Frisco mine is about 10 miles by road from the Katherine mill. A small mill was formerly at the mine and operated intermittently from 1894 to 1914; about 14,000 tons of $14 ore was treated. This mine was being operated by the Gold Standards Mine Corporation in the Spring of 1935. About 75 tons of 0.14 to 0.30 ounce gold was being produced daily with a crew of six men and was trucked to the Katherine mill.

The rock formation consists of a small granite hill capped by a rhyolite flow and rhyolite tuffs. Stringers of banded vuggy quartz occur at the contact to form a vein in previously shattered rhyolite; in some places the mineralization occurs in the underlying granite.

An adit enters the ore on the west side of the hill but passes 35 feet under the ore on the east side due to a fault. Mining formerly was done by a room-and-pillar method with a maximum room height of 18 feet. In the spring of 1935 the stope height had been increased to a maximum of 40 feet in some places by taking out roof and floor pillars. The old pillars were being removed by a retreating system. The ore above the upper adit was transferred through a chute raise to a lower level 120 feet below, along which it is trammed to a truck bin at the surface. The tramway was done on a bonus system.

The faulted part of the vein above the upper level was tapped by a series of short raises from laterals on that level. Ore on the east was mostly drawn off through this chute while that on the west was shoveled. Compressed air was supplied by a small portable one-machine compressor.

The direct mining cost[34/] was about 60 cents. The minimum grade of ore mined was $3 per ton.

34/ Banks, Leon M., Gold Mines at Katherine: Explosives Eng., May 1935, p. 147.

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Portland. - The Portland mine is about 15 miles by road north of the Katherine mill and 6 miles from the Colorado River at an elevation of about 2,200 feet.

J. E. Potter obtained an option on the property in 1934 and later turned it over to the Portland Mines, Inc., who in turn transferred it to the Gold Standard Mines Corporation late in 1935.

In May 1935 the Pioneer Mines, Inc., which had just finished sampling the mines, was building a road to the Katherine mill and had contracted to deliver 50 tons daily to the mill. The milling charge was to be $3.50 per ton, and 93 percent of the gold was to be paid for.

The country rock is granite and andesite. Two ledges occur on the property. The larger dips 53° and is 160 feet across and 210 feet long. It was cut at a depth of 65 feet by a crosscut. It was reported that the ore ran $7.60 per ton. The values in a crosscut 166 feet below the top of the outcrop were reported to contain $4 per ton.

The smaller ledge is a vein that has the same dip, is 6 feet wide, and lies exposed on a side hill of the same dip. It was opened up for 300 feet on the strike and to a depth of 86 feet. The ore was reported to run $15 per ton. The bottom of a 70-foot shaft was in ore.

The large ore body was sampled by drilling and blasting 6-foot holes on the surface and by crosscuts. The cost of the sampling job, including a compressor and the underground workings, was $20,000.

The equipment in May 1935 consisted of a 3/8-cubic yard gasoline shovel and a 500-cubic foot compressor run by a 100-horsepower semi-Diesel engine. The power cost was reported to be 2 cents per horsepower-hour. There is spring flowing about 4 gallons per minute near the camp.

In January 1936 the outcrop of the small ore body was being mined by a gasoline shovel. Drilling was done by jackhammers. The ore was broken to the footwall; the hanging wall was exposed. Later in the season work was transferred to the large ore body. In April a pit 75 feet long and with a face 20 feet high had been excavated. Down holes were being drilled with jackhammers; the ore was being loaded with the yard shovel into trucks for transportation to the Katherine mill.

Road building. - Eleven miles of road from the Katherine mill to the mine was built under contract for $2,500. The contractor used a No. 80 caterpillar tractor and a 12-foot bulldozer with a crew of eight men. The workmen were paid a bonus when over half a mile of road was built in a day. The road crossed a series of deep arroyos and was in generally rolling country. No rock work was necessary. The right of way was covered with desert growth. The contractor surveyed the road by eye as he built it.

Tyro

The Tyro mine is 6 miles by road from the Katherine mill. The drop in altitude from mine to mill is 2,000 feet. During 1915 and 1916 a 500-foot shaft was sunk and some drifting done on the 200-foot level. A small tonnage of ore

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was taken out at this time from pockets at the surface, but the operators missed an ore body that outcropped just below where the shaft was started. In 1933, C. F. Weeks and W. E. Whalley obtained a lease and option on the property and formed the Whitespar Mines Co.; work at the mine began in September 1933.

The country rock is a gneissic granite cut by numerous narrow dikes of rhyolite porphyry. The Tyro vein consists of a silicified fracture zone up to 60 feet in width in the granite. The gold occurs in quartz bands in the vein. Calcite also occurs in the vein but in smaller quantities than the quartz. In places quartz-calcite streaks reach a width of several feet. Where work began the oreshoot was 25 feet wide, but it narrowed down to 10 feet 20 feet below the surface. The minimum width of the shoot where worked is 6 feet. In March 1935 the shoot had been opened up 120 feet on the dip and 240 feet on the strike. The ore shipped in 1935 averaged 0.42 ounce per ton in gold. Surface sampling along the outcrop for about 900 feet indicated a value of $5 to $6 per ton.

The development work consists of an old 500-foot shaft with a drift at the 200-foot level and a new adit 175 feet long. The adit is a crosscut for 75 feet and a drift for 100 feet. Raises have been put up from the drift for ore chutes to an underhand stope above. The drift will be extended and other raises run as needed.

In May 1935 electric power had been brought to the mine. The equipment consisted of a 500-cubic foot electrically-driven compressor, two 100-cubic foot portable gasoline compressors (standby), mine blacksmith shop, and a 100-ton ore bin.

Stoping. - In March 1934, 40 tons of ore was being mined daily from an open-cut on the vein. A part of the dump from the old shaft had to be moved to get at the ore. The mill took the ore in lots of 80 tons.

The old dump and some overburden were removed from the upper part of the vein by a power shovel on contract for a lump sum of $600. Between 2,000 and 3,000 tons of overburden was removed, including 500 tons of solid rock. The contract price did not include breaking the rock. In March 1934 an underhand stope from the surface 10 feet wide by 35 feet long had been extended to a depth of 20 feet.

The ore was drilled with a jackhammer and hoisted in a 10-cubic foot bucket by a small gasoline hoist. The bucket was dumped into a car, which was pushed by hand to a 60-ton bin. The mining was done on contract at $2.50 per ton. The crew consisted of 10 men - 2 miners, 4 muckers, 3 hoistmen, and the contractor. Wages were $4.50 for miners and $4.25 for muckers. The output was 6.6 tons per man-shift for the men in the stope and 4 tons per man-shift for the entire force.

Forty tons of ore was broken with twelve 5½ foot holes; 1-1/3 pounds of explosive was used per ton. Bits were sharpened at the Katherine mill at 10 cents each. Detachable bits were tried but did not prove satisfactory in the hard drilling ground.

The compressor was rented at $2.50 per day and the hoist at $20 per month. The compressor used 15 gallons and the hoist 5 gallons of gasoline per day.

When mining was done as an open-cut the contract price was $1 per ton. The output was 8½ tons per man-shift.

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In May 1935, 100 tons per day were being taken out of the mine through the adit. The ore was mined in 6-foot benches. The blasted ore was drawn through three chutes, without shoveling, into cars that were pulled by a mule to the ore bin in trains of four cars each.

The stope crew consisted of one jackhammer man and one helper on each of two shifts. Two small shrinkage stopes had been run at the ends of the open stope where the ore would not run without shoveling. Shrinkage stoping will be used below the adit level.

No timber had been used for supporting the walls in the open stope up to January 1936. All loose rock had been cleared away at the surface and a wire guard placed around the excavation. The walls were watched closely, and loose blocks were barred down as found.

In March 1934 the crew consisted of; 2 miners, 2 miners' helpers (for stoping), 1 drifting miner, 2 raising miners (for development), 2 trammers, 1 blacksmith, 1 superintendent, and 1 mule.

The mining cost, at 100 tons per day in 1935, was $1.20 per ton. On a 50-ton basis the cost was $1.75.

Panning. - Close control of stoping operations in the open-cut and early operations in the underhand stope was obtained by panning. A good understanding of the ore habits and of the margins of the ore shoot was obtained by this procedure. A close approximation of the value of each part of the vein was also obtained before the material was broken, without waiting for assays; moreover, an appreciable saving was made over the cost of assaying. In the wide portion of the ore-shoot ribs of low-grade material were discarded. Samples across sections of the vein were panned and a composite of the samples was assayed each day. Nearly the full time of one man (an official of the company) was used in taking the samples and doing the panning.

Samples weighing about 6 pounds each were obtained by moiling. About twenty were taken daily; one moil was used for each sample. They were crushed to about minus 3/16-inch in a No. 2 Wheeling crusher run by a 5-horsepower gasoline engine; a sample was crushed and run through a second time in about one minute. After crushing, the sample was screened through 40-mesh and a measure of the fines taken in a cap box. The sample was settled in the box and struck off at the top; it was then panned.

The panning was continually checked against assays. Rejects from assayed samples were used for the control. It had been found that 60 to 70 percent of the gold was in the fines of the crushed sample. The estimate made by panning was usually within 10 percent of the value shown by assays.

Road building. - One-half mile of road up a sandy gulch was built for $150. A power shovel was used for grading. Little blasting was required. A single-track road in disintegrated granite in which no blasting was necessary was built by hand. One man at $4 averaged 16 feet of road construction per day - making the cost per linear foot $0.25.

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Nonproducing mines (May 1935)

Pyramid. - The Pyramid mine probably is the oldest location in the district. It is situated near the Colorado River in some very low hills of granite. The vein consists of stringers in the granite. Some rich ore is reported to have been stoped from a 70-foot shaft.

Golden Cycle. - The Golden Cycle is northwest of the Pyramid mine and has a similar vein. Lausen[35] reports assays of $1 to $3 at the surface and up to $14 underground. A 115-foot shaft with lateral workings has been sunk.

Other properties. - The San Diego, O K Expansion, Union Pass, Monarch, New Chance, and Sunlight properties have been described by Schrader.[36] More or less prospecting has been done on the Black Dyke, Gold Chain, Burke, Mandalay, Bonanza, Banner, Tin Cup, and Quail properties.

Low-grade deposits. - The gold-bearing rhyolite dikes in the Katherine district offer an interesting possibility if the mining and milling costs could be lowered sufficiently. It is estimated that 500,000 tons of $3.50 ore is exposed in the Arabian dike. The "Black dike" about 3 miles to the east of the Katherine mine is exposed for about one-half mile and has a maximum width of 150 feet. It is a calcite vein cut by stringers of quartz in shattered rhyolite. Lausen[37] reports that it runs $2.40 to the ton. The result of sampling done in 1935, however, gave a reported value of over $0.95 per ton.

The Gold Chain about 3 miles from Katherine is similar to the Arabian and is reported to be over 100 feet wide and to run $3 per ton. In addition to the gold-bearing dikes, low-grade deposits have been indicated in several other localities in the district.

Pilgrim district

Pilgrim mine

The Pilgrim mine, the only mine in the Pilgrim district, is 9 miles west of Chloride on the eastern slope of a spur of the main range at an altitude of about 3,600 feet. The deposit was discovered in 1903; a 360-foot inclined shaft was sunk, and a few tons of rich ore were shipped prior to 1907. Further development work was done intermittently until 1934, when the property was acquired by the Pioneer Gold Mining Co. Previous to 1933 about $3,000 had been produced from the mine.

Construction of a mill was begun in July 1934, and mining and milling were started April 1, 1935. In January 1936, 75 tons was being treated daily, and 73 men were employed on the property.

35/ Lausen, Carl, Geology and Ore Deposits of the Oatman and Katherine Districts, Arizona: Arizona Bureau of Mines Geol. Ser. 6, Bull. 131, 1931, p. 119.

36/ Schrader, F. C., Mineral Deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Arizona: U. S. Geol. Survey Bull. 397, 1909, pp. 207-214.

37/ Lausen, Carl, Geology and Ore Deposits of the Oatman and Katherine Districts, Arizona: Arizona Bureau of Mines Geol. Ser. 6, Bull. 131, 1931, p. 119.

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The rocks in the vicinity consist of andesites and rhyolites intruded by dikes of rhyolite porphyry. The mineral deposit occurs within a fault zone that dips 30° and is 50 feet wide. A vein occurs on the footwall and another on the hanging wall of the zone.

A streak of red gouge up to 3 feet in thickness occurs over the ore of the hanging-wall vein. Moreover, both veins are fractured and contain considerable gouge. The veins are made up of irregular stringers and masses of fine-grained quartz with some calcite in silicified country rock. The gold occurs mainly with a green-tinted quartz.

In May 1935 three ore shoots had been opened up in the mine, 125, 70, and 30 feet long, respectively. Two occurred in the footwall vein and one at the hanging wall. The ore averages 3½ feet thick.

All gold is in the free state and in very fine particles. No sulphides occur in the ore but a small amount of pyrolusite is locally associated with the calcite.

Equipment. - The surface mine equipment consists of a 400-horsepower Fairbanks-Morse Diesel plant (cost $55,000) installed late in 1935, a compressor with 100-horsepower motor, an electric hoist, and a 5-horsepower fan. Two 7½-horsepower pumps are used for drainage.

Previous to installing the new power plant, power was supplied by an old 280-horsepower Diesel; the actual output was about 150 horsepower. Air was compressed in a 10- by 12-inch compressor run by a 40-horsepower gasoline engine and hoisting done with a 15-horsepower gasoline hoist. The small compressor did not supply enough air to permit stoping and development work to be carried on at the same time. The gasoline bill for the hoist and compressor was $600 per month.

The mine is developed by a 360-foot, 35° incline working shaft, an air shaft, and four levels. In January 1936 five development headings were being run.

Stoping. - An open-stope method is used. In the hanging-wall stopes the ore is hard, and the walls are soft and heavy. One to two feet of red gouge falls down on the ore if extreme care is not taken to hold it up. In these stopes, stulls with headboards are placed close together. The back is stronger in the footwall stopes and less support is needed.

The dip of the vein is too flat to permit the broken ore to run by gravity. To obviate pulling the ore down chute raises for over 100 feet, crosscuts were run back under the vein and then vertical raises put up to the ore, or sublevels were used.

Stope sections in May 1935 were 40 feet wide. Combined manway and chute raises were put up on the vein on 40-foot centers and timbered with stulls. Each raise was used for two sections. The face of a stope was advanced as an inverted V, the apex midway between two raises. A 5-foot cut was taken and as room was made, stulls with headboards were placed on 5-foot centers in the hanging-wall stopes and, at less frequent intervals in the foot-wall stopes. The ore was shoveled into the ore passes and then pulled down with shovels to chutes, whence it was loaded into cars. The stopes were run about 6 feet high. Extra rock was

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broken at the bottom of the stope to make working room. This waste and the red clay that fell down on the ore were backfilled, but were not enough to fill a stope completely. Plans were made to salvage the stulls as the face advanced and let the back come in but at the time of visit had not been put into effect.

The ore is treated in a flotation mill at the collar of the shaft. Although the gold is readily soluble in a cyanide solution, the clay in the ore is so difficult to settle that the cyanide process did not appear practicable.

The flow sheet as of November 1935 is shown in figure 11. The flotation circuit is shown in figure 12.

The flotation reagents were Aerofloat 15, Dupont B-23, and Amyl and Ethyl xanthate.

A Gibson amalgamator was used in the original flow sheet of the mill ahead of flotation; it recovered 7 percent of the gold. The small amalgamator was first put in to treat the concentrate from the unit cell. This worked so well that the second and larger one was installed for treating all of the concentrate. In May 1935, before the amalgamators were installed, the ratio of concentration was 57 to 1 and the recovery 92 percent. The heads ran 0.476 ounce gold and the tails 0.04 ounce. The flotation concentrate contained 20 to 25 ounces gold and 10 ounces silver. In January 1936 the ratio of concentration was 700 to 1. The concentrate for a month's run consisted of 3-½ tons of 30-ounce material. The overall recovery was 91 percent, of which 90 percent was obtained by amalgamation. Ninety-five percent of the gold recovered in this way was obtained from the first amalgamation.

On March 29, 1936, amalgamation was being done in cyanide solution, according to a letter from O. F. Hastings. It was then run through zinc boxes. All of the gold was obtained as bullion.

In May 1935 the net received by the company for the gold in the concentrate, after deducting trucking and smelter charges, was $29.25 per ounce. The net received for the gold sent to the Mint, after deducting melting, retorting, express, and Mint charges, was $33.75 per ounce.

The motor set-up in the mill in May 1935 was as follows:

	Horsepower
Jaw crusher	10
Gyratory crusher	20
Conveyor	5
Belt feeder	5
Ball mill	100
Unit cell	5
Classifier	5
Sub-A flotation machine, 6 - 1½	9
Kraut flotation machine, 4 - 5	20
Pump	10
Concentrate, thickener	3
Tailing, thickener	10
Total	202

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New water for milling and other purposes was obtained from Willow Springs 7 miles from the mine. It was pumped through 2 miles of 2-inch pipe over a divide with a 400-foot vertical rise and then run by gravity to the mill through 5 miles of 5- and 3-inch pipe. Thirty-five gallons per minute was pumped for 22 hours daily. The pumpmen lived at the spring. Thirty-five percent of the milling water was reclaimed for reuse.

Labor and costs. - The labor required in May 1935 for mining 60 tons daily was 22 men, including 1 blacksmith, 1 hoist engineer, and 1 mine superintendent. The surface labor consisted of 3 Diesel operators at $5, 1 master mechanic at $200 per month, 1 carpenter at $5, 1 pumpman at $125 per month, 1 pumpman at $100 per month, 1 general utility man at $5, 1 manager, and 1 clerk. The total mine and mill labor was 38 men.

The wage scale for the mine was as follows: Miners, $4.50, muckers, $4.00, and hoistmen, $5.00. The mine scale of wages has been raised since May 1935.

The mill required 1 foreman, at $5.50, 3 operators at $5.00, 1 crusherman, at $4.00, 1 swamper, at $4.00, and 1 assayer, at $5.00, a total of 7 men, at $33.50.

The direct cost during the first half of April 1935 was $3.47 for mining and milling. Due to breakdowns of the power plant and changes in the mill the total cost was considerably higher.

Virginia district

The Virginia district as designated by Schrader[38] lies 25 miles northwest of Chloride near the middle of the west slope of the River Range and nearly opposite the Searchlight district in Nevada; the elevation is about 1,500 feet. The country rock consists mostly of rhyolite and green chloritic andesite. The veins dip southwestward and usually have a calcite gangue; they grade into the country rock locally.

Klondyke

The Klondyke mine was first operated in about 1900. According to Wilson,[39] about 4,500 tons of ore from the property was treated in an amalgamation plant on the Colorado River, and later the tailings were cyanided. It is reported that the ore ran $13 per ton.

In the summer of 1935 a lease was taken on the property by Peter Vukoye and associates and shipments were made regularly to the Tom Reed mill; 1,500 tons had been shipped up to January 1936, according to Peter Vukoye.

The ore was mined from four ore shoots in a vein that was 60 feet wide in places. The average grade of ore shipped was $26 per ton. The ore also contained 3 ounces of silver to the ton, but no payments were made for this metal.

38/ Schrader, F. C., Mineral Deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Ariz.: U. S. Geol. Survey Bull. 397, 1909 p. 214.

39/ Wilson, Eldred D., Cunningham, J. B., and Butler, G. M., Arizona Lode Gold Mines and Gold Mining: Arizona Bur. of Mines Min. Tech. Ser. 37, Bull. 137, 1934, p. 80.

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The direct mining cost was $1.85 per ton; trucking cost $5 (82 miles) and milling $4 per ton. The first 10 miles of road was poor.

Golden Door

The Golden Door or Red Gap is about 1 mile north of the Klondyke. Lessees made a few small shipments in 1933 and 1934. The property was idle in May 1935.

The vein is 2 to 4 feet wide; the vein filling is quartz with some calcite. One oreshoot about 50 feet long was the last worked. The mill heads from this shoot ran about $10 per ton.

The ore was treated in a cheaply constructed mill near the Colorado River about 8 miles by road from the mine and about 1 mile from the Searchlight Ferry.

Mill. - The Golden Door mill, of about 25-ton-per-day capacity, was idle in May 1935. It consisted of a 7- by 12-inch crusher, a 4-½ by 4-foot ball mill, a classifier, a flotation cell, and a sluice box. The machinery was run by a 47-½-horsepower gasoline engine. The flow sheet also contained amalgamation plates, but during the last run the plates were cut out and a sluice box was used instead. The mill was in poor condition, and apparently a poor recovery was made. About 250 tons of tailings, including some from an old stamp mill, was piled below the mill.

Dixie Queen

The Dixie Queen is about 2 miles south of the Klondyke. According to Wilson, ore was produced in 1927-28, and some shipping and milling ores were produced several years before. During 1933 and 1934 lessees treated old tailings. In May 1935 the property was idle.

Mocking Bird district

The Mocking Bird district lies about 25 miles northwest of Chloride in a re-entrant parallel side valley in the last foothills of the range at an elevation of between 3,000 and 4,000 feet. Except for some desultory prospecting, no work was being done in the district in May 1935. Three mines, two with mills, were being operated, and several other properties were being developed in 1907 when Schrader visited the district. Relatively little work has been done in the area for the past 20 years.

Mocking Bird

The Mocking Bird mine is in the northern part of the district; the surface is gently sloping. The vein lies nearly flat in a local sheet of flat-lying dike of minette. The vein is about 6 feet thick and consists of red and green quartz and breccia. The gold is free and usually associated with hematite. In March 1935 pillars left at the surface showed considerable copper stain. The ore averaged about $10 per ton.[40/]

40/ Schrader, F. C., Mineral Deposits of the Cerbat Range, Black Mountains, and Grand Wash Cliffs, Mohave County, Ariz.: U. S. Geol. Survey Bull. 397, 1909, p. 214.

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The principal development in 1907 consisted of 12 or 15 shafts ranging from 25 to 60 feet deep and about 500 feet of drifts.

The mine has long been idle. It was worked by a room-and-pillar method; the cover over the flat vein was relatively shallow. Prospecting was done through shallow shafts. The ore was pulled up a slight incline out of the mine then up to the mill bins.

The remrants of a cyanide plant are still on the ground.

Hall

The Hall mine is situated in the southern end of the district in granite. The vein is steeply dipping, varies in thickness up to 2 feet and is associated with diabase dikes. The vein filling is mostly quartz, some being of the honeycomb variety. Some of the ore was very rich.41/ In 1907 a 24-ton mill was being operated at the mine.

The mine was developed in 1907 by a 210-foot shaft and two levels with 200 feet of drifts.

Great West

The Great West mine is near the Hall. The vein is about 3 feet wide and consists of iron-stained quartz. The ore in 1907 was reported to run from $10 to $80 per ton. Fifty tons were shipped to the Kingman sampler in 1926.

Pocahontas

The Pocahontas mine is near the Hall. It is developed to a depth of 200 feet by a shaft and drifts. A cyanide plant had just been built in 1907 to replace an amalgamation mill.

Gold Bug district

The Gold Bug district is near the summit of the range 3 miles north of the Mocking Bird district, 3 miles south of Eldorado Pass, and 30 miles northwest of Chloride. The veins dip steeply and occur in a volcanic rock. The district was busy in 1907, when Schrader visited the area. It was long idle, but in 1935 some interest was again being shown in the area. In addition to the following mentioned mines, work has been done on a number of properties in the district.

Gold Bug

The Gold Bug has been the principal producer in the district. Early operations ceased in 1908. Some development work was done in 1931 and a small tonnage of ore was mined in 1932. In May 1935 Joseph Gardner and partner, lessees, were shipping to the Tom Reed mill. In a year's time 290 tons had been shipped; a 5-ton lot of selected ore ran $72 per ton and 285 tons ran from $14 to $26. The ore came from a shoot 60 feet long in a vein 2 feet wide on the 90-foot level.

41/ Schrader, F. C., work cited (see footnote 40).

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The mine is developed to a depth of 512 feet by a shaft and 5 levels. Open-stope method of mining was used; some waste was sorted out and left in the stopes.

Top-of-the-World

The Top-of-the-World is 29 miles from Chloride and 2-½ miles from the old Kingman-Boulder road. The mine had been idle for about 20 years. The dump shows that considerable underground work had been done; no production data are available.

In May 1935 Arthur Black and three associates had a bond and lease on the property. Three men were taking out some high-grade ore about one-half mile from the main workings.

The country rock is gneiss and granite. A ridge of rhyolite and another one of andesite are near the new workings. The vein consists of a number of fractures cutting the formation. The ore consists of a 6-inch streak of quartz; it contains about 2 ounces of gold to the ton. The gold is free and visible to the naked eye in places. The ore shoot is small. No values are found beyond the 6-inch streak. An open-cut was being made on the ore at the side of an old 30-foot shaft. The cut was down 15 feet at the time of visit. A small shipment had been milled with Gold Bug ore at the Tom Reed.

Mojave Gold

The property of the Mojave Gold Mines Co. is about 1 mile west of the Gold Bug. A camp was built in 1934 and a 112-foot shaft sunk and 500 feet of lateral work done on the 40-foot level. In May 1935 only a watchman was on the property.

Golden Age

The Golden Age is about 1 mile north of the Gold Bug. J. H. Omie, owner, with one man was getting out a shipment from the vein at the surface in May 1935.

The country rocks are schist, granite, and porphyry. The vein dips 25° and is 1 to 6 feet wide, averaging 3 feet. The ore occurs in bunches. A drift has been run 125 feet on the vein.

Eldorado Pass district

The Eldorado Pass district is in the northern part of the range at the Eldorado Pass at an elevation of 2,500 to 3,000 feet. The topography is one of gentle relief. The country rock is granite intruded and locally overlain with volcanic rocks. Schrader briefly mentioned the district but did not describe the individual mines. There has been some minor activity in the area during the past few years.

Pope (Expansion)

The Pope mine is at the side of the old Kingman-Boulder road 32 miles from Chloride on the east slope of the range.

In May 1935 Ben Fortner and Peter Eilson were working the property under a lease and option. In the 4 months previous to May 1935 10 cars of ore had been

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shipped to a Utah smelter. Water for mining purposes was hauled 10 miles from the Colorado River.

The mine is developed by a 100-foot 1-½-compartment shaft with drifts on the 50- and 100-foot levels. The shaft was sunk in 1927 and ore was shipped from a stope on the 50-foot level and from another on the 100-foot level. One 50-ton car of ore gave a return of $1,100.

The vein occurs in the granite, dips 70°, and on the 50-foot level is 1 to 3 feet wide. The high-grade ore occurs in lenses in the vein. Low-grade ore adjoins that which can be shipped. A shoot 50 feet long and with a rake of 40° had recently been mined from above the 50-foot level. One carload ran $100 per ton and nine others about $50 per ton; the total net from the smelter was $11,000. The cut-off for shipping ore was $40 per ton.

The ore, besides gold, contains some lead carbonate and a reported trace of vanadium. No galena had been found up to May 1935. The ore is different in character from any other found in the range. The ore was being mined by an open-stope method in 1935. Two chutes were used in each stope. The ore was hoisted in an 800-pound bucket.

The equipment consisted of an 8-horsepower gasoline engine, a one-machine-capacity portable compressor, and a 20-ton bin.

The ore was trucked 53 miles to Kingman for $3.50 per ton. It was loaded from the bin and shoveled into cars.

Hoover

The Hoover mine is near the Pope. It is developed by a 100-foot shaft. A lessee shipped 5 tons of $60 ore to the Tom Reed in the spring of 1935. The shaft had been sunk within the last 2 years.

Other mines

Schrader mentions the Burrows, Bogg, Young, and Pauley as the principal mines in the district in 1907. He states that the Burrows had a reported production of $10,000.

SUMMARY

Gold deposits occur throughout the Black Mountains of western Mohave County. Gold is the only valuable metal (except a minor amount of associated silver) found in the range; there is a remarkable similarity in the occurrence of gold in the veins.

Several periods of activity have occurred in the range with relatively quiet periods between. The first mining was in the early sixties, when some rich surface deposits were found. At the beginning of the century work was being done throughout the range at a large number of deposits. The greatest activity in the Oatman district was between 1917 and 1924 during the life of the United Eastern, from which $14,000,000 in gold and silver was produced. The so-called "Oatman boom" occurred at this time, and considerable unproductive work was done on

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wildcat promotions. After the boom, production fell off gradually, and at the beginning of 1933 the area outside of Oatman, where one small mine was operating, was virtually deserted except for desultory work by a few lessees.

Interest was revived in the range when the higher price of gold was established. The Tom Reed and Katherine mills were again put in commission and began taking custom ore; before long more custom ore was being offered than could be accepted. This condition persisted up to the time of writing (spring, 1936). The Tom Reed, Gold Roads, and other old mines were reopened. Important new ore bodies were discovered in the Tyro, Ruth-Rattan, Portland, Minnie, and other mines. One new mill, the Pilgrim, was built in 1934. This was at an old mine with a negligible previous production. The total production to the end of 1933 was $37,000,000 in gold and over $600,000 in silver.

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